THREE ESSAYS ON MIGRATION, REMITTANCES AND HUMAN CAPITAL FORMATION

Hilcías E. Morán

Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
of the degree
Doctor of Philosophy
in the Department of Economics,
Indiana University
August 2009

Accepted by the Graduate faculty, Indiana University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Doctoral Committee:

Gerhard Glomm (Chair)

Michael Alexeev

Rubiana Chamarbagwala

Ricardo López

Date of dissertation defense: August 10, 2009.

Dedicated to my wife, Aída, my mom, María Dilia and to my children, Santiago, Sebastián, María Fernanda and Oscar Estuardo. I also dedicate it to the memory of my dad, Oscar (1923-1999), and to my sisters, Eunice, Delia, Ruth and María Elena and brothers, Oscar and Elías.

Acknowledgments

I would like to thank my committee members for for their insightful comments, suggestions, and commitment. I would like to thank Gerhard Glomm for his thoroughness, his helpful insight, support, guidance, and his time. My research has benefited greatly from his collaboration. I would like to thank the members of the Growth and Public Economics working group at Indiana University.

I am grateful to the central bank of Guatemala (Banco de Guatemala) for its financial support during my time at Indiana University. I would like to thank Jounghyeon Kim for his helpful suggestions and also for being such great friend. I would like to thank Chris Cunningham for her understanding and time.

I want to extend the greatest gratitude to my family, whose support and encouragement are the main reason why I have made it this far. Especially, I would like to thank my wife Aída, whose love, understanding and devotion have been crucial to finish my degree.

Abstract

This dissertation investigates three topics related to migration and human capital formation in developing countries. The first essay attempts to determine the conditions under which exposure to international migration can have a positive effect on economic growth. Numerical simulations show that the lower the contribution of private investment in education to human capital accumulation in the source countries, the higher the likelihood that exposure to international migration negatively impacts economic growth if migration is sufficiently high. The level of efficient government expenditure on education is higher for an economy with migration than for an economy without migration only if migration has a positive effect on growth. The second essay analyzes the determinants of remittances using household data from Ecuador. It provides empirical evidence as follows: remittances and household migration size are non-monotonically related, remittances are altruistically motivated, the size of remittances decreases with time after migration and the Ecuadorian migrants who moved to the U.S. are more likely to remit and to remit more than those who moved to other countries. The third essay of this dissertation combines data from the 2002 National Population Census and the distribution of the number of victims and human rights violations across 22 departments to examine how the worst period of the civil war in Guatemala, between 1979 and 1984, affected human capital accumulation. The identification strategy exploits variation in the war's intensity across departments and which cohorts were of school age during the war. It finds a strong negative impact of the civil war on female education. The 2002 data reveal that the worst period of the war appears to have intensified both regional and gender disparities.

Contents

Introduction **1**

1 Migration, Financing Education and Economic Growth: An Integrated Analysis **5**

1.1 Introduction 5

1.2 A simple growth model with migration 11

1.2.1 Firms 12

1.2.2 Public finance 12

1.2.3 Households 13

1.2.4 Dynamic equilibrium 17

1.3 Solving the model 18

1.3.1 Aggregate income with migration 19

1.3.2 Physical capital and human capital 20

1.3.3 Output and migration rate 21

1.4 Stationary competitive equilibrium 22

1.4.1 Equilibrium migration rate 23

1.4.2 Stationary prices of factors, consumption, intergenerational transfers and economic growth rate 23

1.5 Calibration and computational analysis 26

1.5.1 The equilibrium migration rate 27

1.5.2 The tax rate and the economic growth rate 27
1.5.3 The migrants' wages, the parents' degree of altruism and the economic growth rate 32
1.5.4 The "subjective" migration costs and the economic growth rate . . . 33
1.6 Conclusions and final comments 35
Appendix 39
Figures 40
2 Determinants of Remittances: Theory and Evidence from Households in Ecuador 48
2.1 Introduction 48
2.2 Basic theoretical framework 52
2.2.1 The model 52
2.2.2 Time profile of remittances 57
2.3 Empirical Analysis 59
2.3.1 Reduced form of remittances equation 59
2.3.2 Data 60
2.3.3 Empirical methodology 61
2.3.4 Results 65
2.4 Conclusions and final comments 71
Tables 73
3 Human Capital Consequences of Civil War: Evidence from Guatemala (with Rubiana Chamarbagwala) 79
3.1 Introduction 79
3.2 Civil War in Guatemala 87
3.2.1 Political History 87

3.2.2 Civilian Impacts of the War 89
3.3 Data and Estimation 91
3.3.1 Data 91
3.3.2 Empirical Analysis 95
3.4 Results 99
3.4.1 Baseline Difference-in-Differences Estimation 99
3.4.2 Grade Completion 103
3.4.3 Schooling Outcomes for Displaced or Migrant People 106
3.4.4 Post-War Schooling Outcomes 109
3.5 Conclusion and final comments 111
Figures 114
Tables 122
4 Conclusions **138**
Bibliography **143**

List of Tables

2.1 Ecuadorian Migrant Remittance Behavior by Number of Migrants within the Household 73

2.2 Ecuador: Migrant and Non-migrant Characteristics 74

2.3 Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances in U.S. Dollars for the OLS Model 75

2.4 Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances in U.S. Dollars for the OLS Model 76

2.5 Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances per Household Member (Receivers) in U.S. Dollars for the OLS Model . . . 77

2.6 Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances per Household Member (Receivers) in U.S. Dollars for the OLS Model . . . 78

3.1 Cohorts Unexposed and Exposed to the Civil War 122

3.2 Disparities in Educational Attainment: by Gender, Region, Sector, and Ethnicity 123

3.3 Difference-in-Differences Comparing Exposed with Unexposed Cohorts in High and Low War Intensity Departments: Years of Schooling for Males . . 124
3.4 Difference-in-Differences Comparing Exposed with Unexposed Cohorts in High and Low War Intensity Departments: Years of Schooling for Females . 125
3.5 Civil War Exposure and Years of Schooling 126
3.6 Civil War Exposure and Years of Schooling: Control Experiment 127
3.7 Completion of Primary School Grades: Using Human Rights Violations to Measure Civil War Intensity 128
3.8 Completion of Secondary and High School Grades: Using Human Rights Violations to Measure Civil War Intensity 129
3.9 Completion of Primary School Grades: Using Victims to Measure Civil War Intensity 130
3.10 Completion of Secondary and High School Grades: Using Victims to Measure Civil War Intensity 131
3.11 Control Experiment Using Human Rights Violations to Measure Civil War Intensity 132
3.12 Control Experiment for Completion of School Grades Using Victims to Measure Civil War Intensity 133
3.13 Schooling of Migrant and Non-migrant Males 134
3.14 Schooling of Migrant and Non-migrant Females 135
3.15 Cohorts Used in Post-War Analysis 136
3.16 Probability of Completing Primary School Grades for Post-War Cohorts . . 137

List of Figures

1.1 Migration Rate at Equilibrium 41

1.2 Labor Income Tax Rate Effect on Economic Growth for Different Values of the Contribution of Private Investment in Education (δ) to Human Capital Formation 42

1.3 Labor Income Tax Rate Effect on Economic Growth for Different Values of the "Subjective" Migration Costs (η) 43

1.4 Host Country Real Wages Effect on Equilibrium Migration Rate and Economic Growth Rate 44

1.5 Degree of Human Capital Altruism Effect on Equilibrium Migration Rate and Economic Growth Rate 45

1.6 Degree of Physical Capital Altruism Effect on Equilibrium Migration Rate and Economic Growth Rate 46

1.7 Preference for Living in the Source Country Effect on Economic Growth for Different Values of the Contribution to Human Capital Formation of Private Investment in Education (δ) 47

3.1 Map of Guatemala 115

3.2 Number of Killings and Disappearances in Guatemala: 1960-1996 116

3.3 Number of Victims and Human Rights Violations Per 1000 Population in Departments 117
3.4 Years of Schooling of Males Born Between 1920 and 1983 in High War Intensity (HWI) and Low War Intensity (LWI) Departments 118
3.5 Years of Schooling of Females Born Between 1920 and 1983 in High War Intensity (HWI) and Low War Intensity (LWI) Departments 119
3.6 1964 Enrollment Rates, Availability of Water and Electricity in 1964, and Rank of Departments (by Number of Human Rights Violations) 120
3.7 1964 Enrollment Rates, Availability of Water and Electricity in 1964, and Rank of Departments (by Number of Victims) 121

Introduction

This dissertation examines three topics related to migration and human capital formation in developing countries. The first chapter studies the conditions under which exposure to international migration can have a positive effect on economic growth. There are four numerical findings associated with the effects that government expenditure on education (and, hence, the tax rate) has on growth in this chapter.

First, the economic growth rate is nonmonotonically correlated with the tax rate. For low levels of taxation there is not enough human capital and for high levels of taxation there is not enough physical capital. In this framework, growth depends on public education expenditures as a share of output, the physical-human capital ratio and private investment in human capital. When taxes are used to finance public education, government expenditure on public education unambiguously lowers both the physical-human capital ratio and private investment in education. The crowding out of physical capital and private investment in education diminishes, and even reverses, the positive direct effect of public education expenditures on growth.

Second, the economic growth rate for an economy with migration is higher than the economic growth rate for an economy without migration for any level of the tax rate. There are both direct and indirect effects of the tax rate on physical-human capital ratio and private investment in education. When taxes increase, both physical-human capital ratio and private investment in education decrease. This is the direct effect. The indirect effect works as follows: when taxes increase, the prospective migrant workers are more likely to move from the low real wages country (the source country) to the high real wages country (the host country) and, therefore, both the private investment in education and physical

capital are encouraged by the migrants' higher labor income earned in the destination country. Therefore, indirectly this positively affects physical and human capital formation in the source country. Even though the total effect of the tax rate on the physical-human capital ratio and private investment in education is unambiguously negative for both economies, the economy with migration and the economy without migration, the magnitude of the negative effect of the tax rate is lower for an economy with migration than for a closed economy.

Third, the efficient level of government expenditure is lower for an economy without migration than for an economy with migration when exposure to international migration positively affects growth. Fourth, the maximizing-growth tax rate is lower for an economy with low migration costs than for an economy with high migration costs because the former economy would face a relatively high migration rate. Another finding of this chapter suggests that if the migration rate is sufficiently high, the lower the contribution of private investment in education to human capital accumulation, the higher the likelihood that exposure to international migration negatively impacts economic growth in the source countries.

The second chapter develops a simple analytical model with altruistically motivated remittances to analyze the determinants of remittances using household data from Ecuador. In the model it is assumed that an individual migrant takes as given the amount of remittances sent by all other migrants within the same household and that migrants are exogenously located in different host countries. When the migrant opportunity cost of forgone household labor income is taken into account, this model suggests that migrant remittance behavior and household migration size are non-monotonically correlated. The empirical part of this chapter provides evidence that migrant remittances are a non-increasing function of the

number of migrants within the household in Ecuador. Moreover, it shows robust evidence in favor of altruistically motivated remittance behavior and it shows that the size of remittances decreases over time since migration. Finally, it finds that Ecuadorian migrants who moved to Spain were less likely to remit and remit less than those migrants whose destination country was the United States.

Finally, in the third chapter, which is coauthored by Rubiana Camarbagwala, we combine data from the 2002 National Population Census and the distribution of the number of human rights violations and victims across 22 departments to examine how Guatemala's 36-year-long civil war affected human capital accumulation. The year of birth and the department of birth jointly determine an individual's exposure during school age to three different periods of the civil war, namely the initial period (1960-1978), the worst period (1979-1984), and the final period (1985-1996). We find a strong negative impact of the civil war on the education of the two most disadvantaged groups, namely rural Mayan males and females. Among rural Mayan males, those who were school age during the three periods of the civil war in departments where more human rights violations were committed completed 0.27, 0.71, and 1.09 years less of schooling respectively whereas rural Mayan females exposed to the three periods of the war completed 0.12, 0.47, and 1.17 years less of schooling respectively. Given an average of 4.66 and 3.83 years of schooling for males and females, these represent declines of 6, 15, and 23 percent for males and 3, 12, and 30 percent for females. Our results are robust to the inclusion of indicators for department of residence, year of birth, and controls for different trends in education and human development in war affected and peaceful departments of Guatemala and suggest that the country's civil war may have deepened gender, regional, sectoral, and ethnic disparities in schooling.

This dissertation is structured as follows. Chapter 1 studies the conditions under which

exposure to international migration can have a positive effect on economic growth. Chapter 2 examines the determinants of remittances using household data from Ecuador. Chapter 3 investigates how Guatemala's 36-year-long civil war affected human capital accumulation and Chapter 4 concludes.

1 Migration, Financing Education and Economic Growth: An Integrated Analysis

1.1 Introduction

A number of papers have analyzed the link between government expenditure on education and economic growth by building endogenous growth models where public education expenditures directly influence human capital accumulation and consequently affect long-term growth. Examples include Glomm & Ravikumar (1992, 1998), Glomm (1997), Kaganovich & Zilcha (1999), and Blankenau & Simpson (2004). Another set of studies have examined the relationship between migration and growth by developing models where migration affects the availability of high-skilled workers in the source countries and hence affects economic growth. Among those studies, Miyagiwa (1991) develops a model with scale economies in advanced education to analyze human capital formation for both host and source countries and concluded that a "brain drain" will impact upon the availability of intermediate skilled workers in the source country. Stark et al. (1998) suggest that potential migration raises the return on human capital that will in turn raise the average level of human capital in the source country ("brain gain"). Chen (2006) analyzes the impact of exogenous international migration on the economic growth of a source country in a stochastic setting. The model accounts for endogenous fertility decisions and distinguishes between public and private schooling systems. This study finds that relaxation of restrictions on the emigration of high-skilled workers will damage the economic growth of a source country in the long run,

although a "brain gain" may happen in the short run. Furthermore, the growth rate of a source country under a private education regime will be more sensitive to the probability of migration than a country under a public education regime.

This paper proposes a simple two-period overlapping generation growth model, with endogenous international migration, intergenerational transfers and human capital technology based on private investment in, and real government expenditure on, education, to examine the implications of being exposed to international migration for economic growth in the source countries. In particular, this paper attempts to understand the association between migration and the way of financing human capital in the source countries.

This analysis depart from the migration and growth literature in three ways. First, migration decisions are endogenously determined. Individuals derive utility from joining the labor market in the source country. This preference captures the fact that workers are likely to have a preference for their native country's life-style because of cultural factors, family relationships, and so on. According to the United Nations (2002), ninety seven percent of the world's population remain in the country where they were born. Some studies have asked "Why have more people not emigrated?"[1] Lucas (2005) points out: "One plausible answer is that state controls on migration limit legal movements and even restrict undocumented flows by imposing a cost on irregular entry. More generally, the financial costs of international relocation can be prohibitive for many. Yet financial and legal barriers alone may not suffice to explain the limitations observed on international migration. In reality, many people simply prefer to stay at home in familiar surroundings, with friends and family. This last concern may offer important insights into two well-observed patterns in international migration, namely the tendency not to move far and the

[1] Hammar & Tamas (1997), Freeman (1993) and Lucas (2005) pose this question. The first two studies are related to migration to the U.S. from Mexico, whereas Lucas (2005) is a more general approach.

propensity to move where others have gone before" (p. 26 in Chapter II). The preference for joining the labor market in the source country plays a relevant role in making migration decisions and this paper recognizes this fact.

Second, the paper allows private voluntary transfers by assuming that migration decisions are household decisions and not individual decisions.[2] Remittances have been widely studied in the literature.[3] These private transfers might imply a positive effect of exposure to migration for the source country. The flow of remittances from migrants to their relatives in the source country has exhibited a rapid and accelerating rate of growth.[4] It surpasses foreign aid and is the largest source of foreign capital for several labor-exporting countries. These private transfers may encourage physical-human capital investment in the source countries. Some empirical studies suggest that remittances might have a positive effect on human capital formation, Hanson & Woodruff (2003) on Mexico and Cox & Ureta (2003) on El Salvador, whereas Osili (2007), using matched data (migrants and their relatives) from Nigeria, finds that remittances are likely oriented toward savings.

This paper also assumes that migration decisions are made in adulthood and, since individuals acquire some education level when young, migration decisions might involve a migration cost for the labor-exporting countries. Government taxation of labor income is used to fund public expenditure on education in this paper. The key difference between this paper and those studies without migration, such as those of Glomm & Ravikumar (1992) and Kaganovich & Zilcha (1999), among others, is that while all young individuals who received free public education are taxed as adults in an economy without migration, this

[2]Some of the leading papers dealing with migration decision theory are Sjaastad (1962), Todaro (1969) and Borjas (1987, 1989), in which the migration decision is a function of two main variables: wage differential and migration cost.

[3]See Lucas & Stark (1985), Funkhouser (1995) and a literature review in Docquier & Rapoport (2006).

[4]According to World Bank data the share of remittances as a percentage of gross domestic product has grown steadily through the last three decades. By the end of the 1970s remittances for all developing countries represented only around 0.5 percent of the GDP while in 2006 it reached around 2.0 percent.

paper recognizes that only individuals who stay in the source country when older are taxed. The migrant workers are not taxed, even though they may have acquired free education in the source country when young.[5]

In general, international migration may imply various costs. For the source countries, these costs include the loss of the skilled migrants' positive impact on society and the resources used to educate them. Migrants are likely to suffer from the separation from family, friends, and culture, and from the lack of effective legal protection. Costs for destination countries include the perceived threat to cultural identity and the effect of the migrants' competition with the natives for the same jobs (Özden & Schiff 2006). This paper takes into account the costs involved in the departure of migrant workers from the source countries.

There are four numerical findings in this paper associated with the effects on growth of government expenditure on education (and, hence, tax rate). First, the economic growth rate is nonmonotonically correlated with the tax rate. For low levels of taxation there is not enough human capital and for high levels of taxation there is not enough physical capital. Similar to the Blankenau & Simpson (2004) setting, in this framework, growth depends on public education expenditures as a share of output, the physical-human capital ratio and private investment in human capital. When taxes are used to finance public education, government expenditure on public education unambiguously lowers both the

[5] As discussed by Lucas (2005), p. 16 in Chapter IV), there are two components related to the fiscal effects of emigration, namely "the loss of any net contribution that the educated migrants would have made to the fiscal balance, had they remained at home; and the fact that education is subsidized, and hence the view that emigration also exports the returns on this public investment". Related to the forgone income tax revenue associated with migrant workers, a computation study for India by Desai et al. (2003), concludes: "foregone income tax revenues associated with the Indian-born residents in the U.S. comprise one-third of current Indian individuals income tax receipts. Depending on the method for estimating expenditures saved by the absence of these emigrants, the net fiscal loss associated with the U.S. Indian-born resident population ranges from 0.24% to 0.58% of Indian GDP in 2001." A paper by Desai et al. (2009), related to Indian migrant workers as well, finds that conservative estimates indicate that the annual net fiscal impact to India of high-skilled emigration to the U.S. is one-half of 1% of gross national income (or 2.5% of total fiscal revenues). Hence, as Lucas concludes: "the balance of the outcomes is far from obvious in general, and will depend critically upon the direct and indirect tax systems in place as well as patterns of public spending across socioeconomic groups. One should not expect a uniform answer."

physical-human capital ratio and private investment in education. The crowding out of physical capital and private investment in education diminishes, and even reverses, the positive direct effect of public education expenditures on growth.

Second, the economic growth rate for an economy with migration is higher than the economic growth rate for an economy without migration for any level of taxation. There are both direct and indirect effects of the tax rate on physical-human capital ratio and private investment in education. When taxes increase, both physical-human capital ratio and private investment in education decrease. This is the direct effect. The indirect effect works as follows: when taxes increase, the prospective migrant workers are more likely to move from the low real wages country (the source country) to the high real wages country (the host country) and, therefore, both the private investment in education and physical capital are encouraged by the migrants' higher labor income earned in the destination country. Therefore, indirectly this positively affects physical and human capital formation in the source country. Even though the total effect of the tax rate on the physical-human capital ratio and private investment in education is unambiguously negative for both economies, the economy with migration and the economy without migration, the magnitude of the negative effect of the tax rate is lower for an economy with migration than for a closed economy. The obvious difference between this economies with and without migration is that the indirect effect for the latter does not exist because labor supply is fixed. Hence, one expects that any increase of taxes would have a stronger negative effect on the physical-human capital ratio and private investment in education in a closed economy than in an open economy. According to Miyagiwa (1991), there are two issues that have dominated the literature on "brain drain". The first is the welfare effects of migration. If the migration rate is sufficiently small in size, it does not affect the welfare of the residents in the source country, but

at a certain level emigration is welfare-reducing to those left behind. The second issue is the identification of the appropriate policies to compensate for the welfare losses suffered by the non-migrant workers. Bhagwati's proposal calls for income transfers, via taxation, from the skilled migrants living in developed countries to those left behind. Private transfers from migrants to those left behind may play the role of the income transfers via taxation proposed by Bhagwati, encouraging economic growth in the economy with migration and, therefore, reducing, or even reversing, the negative effect suggested by the "brain drain" literature.

The third numerical finding of this paper concerning taxation and growth is that the efficient level of government expenditure is lower for an economy without migration than for an economy with migration when exposure to international migration positively affects growth. Fourth, the growth-maximizing tax rate is lower for an economy with low migration costs than for an economy with high migration costs because the former would face a relatively high migration rate.

Another finding of this paper suggests that if the migration rate is sufficiently high, the lower the contribution of private investment in education to human capital accumulation, the higher the likelihood that exposure to international migration negatively impacts economic growth in the source country.

If private transfers are allowed, exposure to international migration is more likely to encourage economic growth in the labor-exporting countries only if the contribution of private investment in education to the overall production of human capital is not too low and the migration rate is not too high. Given the observed data on migration rates (Docquier & Marfouk 2006) and the empirical evidence of the contribution of government expenditure on education (Coleman 1966, Card & Kruger 1992) to human capital formation, there is

a potential gain in economic growth for developing countries if developed countries tend toward the relaxation of immigration policies as predicted by Özden & Schiff (2006).

The next section describes the theoretical model and states the equilibrium definition. Section 3 solves the model. Section 4 shows stationary equilibrium results. Section 5 shows calibration and computational analysis, from which are obtained the main results of this paper. Finally, section 6 offers some concluding remarks.

1.2 A simple growth model with migration

Consider an overlapping generations economy. In every period the economy produces a single homogeneous good that can be used for consumption and investment. The good is produced using physical capital and human capital. The stock of physical capital in every period is the total income in the preceding period net of consumption and human capital investment, while the stock of human capital in every period is determined by the aggregate public expenditure on education and the proportion of income allocated to human capital formation. Migrants move to a higher wage country, where immigrants from their particular source country represent only a small fraction of the total population and hence are unable to affect real wages in that country. The migrants do not carry physical capital from the source country to the host country. Prices are assumed to be the same across the source and the host countries.[6]

[6]This assumption does not change any of the substantive predictions of the model used here. Djajic (1989) and Dustmann (1997, 1999) use international migration models in which it is assumed that prices are higher in the host country relative to prices in the source country. This issue is not considered here, mainly to maintain simplicity and partially because it would be more relevant if we were modeling return migration as analyzed by Djajic (1989) and Dustmann (1997, 1999).

1.2.1 Firms

Producers face competitive output and input markets and maximize profits. The production process occurs within a period according to a neoclassical, constant returns-to-scale, Cobb-Douglas technology using physical capital and human capital as inputs. The output produced at time t, y_t, is given by

$$y_t = AK_t^{\alpha} H_t^{1-\alpha}, \tag{1.1}$$

where K_t and H_t represent physical and human capital, respectively, employed in production at time t, $\alpha \in (0,1)$ and the constant $A > 0$ denotes the total factor productivity. Physical capital depreciates fully after one period. Given the wage rate per efficiency unit of labor, w_t^h, and the gross rate of return to capital, $1 + r_t$, producers in period t determine the level of employment of capital and the number of efficiency units of labor so as to maximize profits. That is, $\{K_t, H_t\} = \arg\max[AK_t^{\alpha} H_t^{1-\alpha} - (1 + r_t)K_t - w_t^h H_t]$. The firms' inverse demand for factors of production is then

$$1 + r_t = \alpha A K_t^{\alpha-1} H_t^{1-\alpha} \tag{1.2}$$

$$w_t^h = (1-\alpha) A K_t^{\alpha} H_t^{-\alpha}. \tag{1.3}$$

1.2.2 Public finance

Labor income taxation is the sole source of government revenue. A constant fraction $\tau \in (0,1)$ of labor income generated in the source country in period $t+1$ is collected by the government in order to finance public education, while the rest, $1-\tau$, is used for consumption and future income. Labor income generated by migrant workers is not taxed here. As discussed by Wilson (2008), government taxation of the migrants' labor income would require the developed countries' cooperation, which implies a number of administra-

tive obstacles. Hence, only labor income of non-migrant workers is taxed in this economy.[7] Public education is provided free of charge equally for all individuals.

Government taxation of labor income thus results in tax revenue, $\tau w_t^h H_t$, at time t. It is used to fund public expenditure on education, E_t. As will be apparent below, the key difference between this intergenerational transfer and that considered in a model without migration, such as those of Glomm & Ravikumar (1992) and Kaganovich & Zilcha (1999), among others, is that while all young individuals who received free public education are taxed as adults in an economy without migration, in this model only individuals who stay in the source country when older are taxed. The migrant workers are not taxed, even though they acquired free education in the source country when young. To the best of our understanding, the cost of educating migrant workers has not been taken into account before in the literature on migration and economic growth. Here it is assumed that the government budget is balanced in each time period t,

$$E_t = \tau w_t^h H_t. \tag{1.4}$$

1.2.3 Households

In every period a generation consists of a continuum of cohesive social groups or households (i.e. extended families) of measure 1 and each of these social groups is endowed with one unit of labor supply (i.e. $l = 1$). Each household across generations is composed of the same number of parents and the same number of children. This assumption means that there is no population growth. Individuals within households live for two periods. Individuals within, as well as across, generations are identical in their preferences and innate abilities. Preferences of individuals who are born in period t are defined over second period

[7] Mirrlees (1982) examines a nonlinear income tax model in which both residents and emigrants are taxed. He finds that emigrants should be taxed at relatively high rates.

consumption, c_{t+1}, a transfer to their offspring used to finance physical capital investment, b_{t+1}, a transfer to their offspring used to finance private investment in education, e_{t+1},[8] and, given the fact that people generally prefer living in their country of origin, a joy of living in the source country in the second period of life, $l_{h,t+1}$. Preferences are represented by a log-linear utility function

$$u_t = (1-\theta-\mu)\ln c_{t+1} + \theta \ln e_{t+1} + \mu \ln b_{t+1} + \eta \ln l_{h_t+1}, \tag{1.5}$$

where $\theta, \mu \in (0,1)$. The preference for joining the labor force in the source country captures the fact that workers are likely to have a preference for their native country's life-style because of cultural factors, family relationships, and so on.[9]

In period t individuals receive two types of transfers, b_t and e_t, and acquire human capital. In this model parents decide the allocations of human capital investment, e_t, and physical capital investment, b_t, to their offspring. As noted by Glomm (1997), in many developing countries the number of years school is attended is very low. Hence, if a child attends school for few years one might assume that the relevant educational choices are made by the parent and not by the child.[10] Notice also that first period consumption may be thought of as part of the consumption of the parent. Individuals devote their first period to the acquisition of human capital. Individuals within a household equally share the amounts they inherit from their preceding generation. In the second period of their lives individuals join the labor market, either as migrant workers or non-migrant workers, allocating the

[8] This form of altruistic bequest motive (i.e. "joy of giving") is the common form in the recent literature on income distribution and growth. Under the form of "joy of giving", individuals simply allocate their wealth optimally between their own consumption and bequests to their offspring. This approach is supported empirically by Altonji et al. (1997).

[9] An alternative way of introducing these preferences for living and working in the source country is to apply a discount factor, $0 < \kappa < 1$, to the host country wage rate when comparing it with the source country wage rate (Stark et al. 1998, Docquier & Rapoport 2006).

[10] I conjecture that qualitative results would remain intact if parents endow a total transfer, T_t, and then the children allocate the total transfer T_t between human capital investment and savings in the first period.

resulting labor income, along with their return on capital, between consumption and the two types of transfers to their children. Hence, migrant workers and non-migrant workers within the same household behave altruistically toward their children within the household. The amount of productive human capital (measured in efficiency units of labor), which is available to an individual in the second period of her life, is an increasing function of the real government expenditure on education, $E_t > 0$, and of the amount that a household chooses to allocate to human capital accumulation, $e_t > 0$. The number of efficiency units of human capital of each member of generation t in period $t+1$, h_{t+1}, is given by:

$$h_{t+1} = B e_t^{\delta} E_t^{1-\delta}, \tag{1.6}$$

where $B > 0$ is a constant.[11]

The labor supply of a household which is exposed to international migration in period t is $1 = l_{h,t} + l_{m,t}$, where $l_{h,t} > 0$ represents the fraction (and the number) of individuals from this household in the source country and $l_{m,t} \geq 0$ denotes the fraction (and the number) of workers from the same household in the host country. In this model zero financial migration costs is assumed and therefore all the first period household income is allocated between human and physical capital investment. Including financial migration costs would not affect the main findings of this basic model. Sjaastad (1962) distinguishes two types of private migration costs: the out-of-pocket or financial costs and the non-money costs (forgone earnings and "psychic" or "subjective" costs of changing one's environment). In this paper the forgone earnings costs are internalized by assuming that migration decisions are household decisions, whereas the "subjective" costs are incorporated indirectly in the preferences of living in the source country. In the second period of life, members of genera-

[11] As follows from the human capital production function, human capital accumulation is active in $t+1$ as long as $e_t > 0$ and $\tau_t \in (0, 1)$.

tion t join the labor force as either non-migrants in the source country or migrant workers in the host country. Non-migrant workers earn the wage rate per efficiency unit of labor, w^h_{t+1}, and migrant workers earn the exogenous constant wage rate, w^m.[12] The host country wage rate, w^m, is defined net of any migration-related costs and taxes in the host country. The interpretation of the assumption that the host country wage rate is exogenous is that the source country is small in the sense that it has only a negligible impact on wages in the host country. In addition, a household derives income from capital ownership, $b_t(1 + r_{t+1})$. The household's second-period income, I_{t+1}, is hence

$$I_{t+1} = (1 - \tau)(1 - l_{m,t+1})w^h_{t+1}h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1 + r_{t+1}). \tag{1.7}$$

Real wages in the host country is independent of migration, while real wages in the source country is positively associated with the migration rate. Mishra (2007) uses data from the U.S. and the Mexico Population Census (1970-2000) to investigate the impact of international migration on wages in Mexico and finds that emigration has a positive and significant effect on Mexican wages: a 10 percent decrease in the number of Mexican workers due to emigration in a skill group increases the average wage in that skill group in Mexico by 4 percent. Notice also that we assume that human capital is perfectly transferable between the source country and the host country and all earnings in the foreign country go into the household's income.[13]

[12] Even though the real wages in the host country are assumed constant, as will be seen later, the convergence of wages across the source countries and the host countries does not occur in this model because of the individuals' preference for joining the labor market in the source country. Here, the wage rate per efficiency unit of labor in the host country is assumed constant for simplicity, but if this assumption is modified so that it can grow constantly over time, the main findings of this paper would remain unchanged.

[13] Under the assumption that labor income is always higher in the host country than in the source country, assuming that human capital is partially transferable would not alter the main results of this paper, but would complicate the solution of the model. One also might assume that only a fraction, $\triangle \in [0, 1]$, of labor income in the host country goes into the household's income, but it would not affect the qualitative predictions of this paper because, as will be apparent later, this is just a scale parameter. In addition, notice that c_{t+1} denotes the household consumption, which includes the migrant and the non-migrant consumption. This is possible because prices are assumed to be the same across the source and the host countries.

The household problem is to allocate second period income between consumption, c_{t+1}, and transfers to the offspring, b_{t+1} and e_{t+1}, so as to solve the following maximization problem (P1):

$$v_t = Max_{\{c_{t+1},e_{t+1},b_{t+1},l_{m,t+1}\}} \ (1-\theta-\mu)\ln c_{t+1} + \theta \ln e_{t+1} + \mu \ln b_{t+1} + \eta \ln(1-l_{m_t+1})$$

$$s.t.$$

$$c_{t+1} + e_{t+1} + b_{t+1} = (1-\tau)(1-l_{m,t+1})w^h_{t+1}h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1+r_{t+1}),$$

$$h_{t+1} = Be^{\delta}_t E^{1-\delta}_t,$$

given $\{\tau, E_t, e_t, w^h_{t+1}, w^m\}$.

1.2.4 Dynamic equilibrium

Given the initial transfers, b_0 and e_0, a *dynamic competitive equilibrium* is a collection of the sequences of individual household decisions $\{e_{t+1}, b_{t+1}, c_{t+1}, l_{m,t+1}, h_{t+1}\}^{\infty}_{t=0}$, the sequences of aggregate amounts of physical capital and effective labor $\{K_t, H_t\}^{\infty}_{t=0}$, the sequences of factor prices $\{w^h_t, 1+r_{t+1}\}^{\infty}_{t=0}$, and the sequence of real government expenditure on education $\{E_t\}^{\infty}_{t=0}$ such that:

1. For each $t = 0, 1, \ldots$, the collection $\{e_{t+1}, b_{t+1}, c_{t+1}, h_{t+1}, l_{m,t+1}\}$ solves the individual household maximization problem (P1),

2. Capital markets clear, so the aggregate stocks of physical and human capital are given, respectively, by the following relationships:

$$K_{t+1} = b_t \tag{1.8}$$

$$H_t = (1-l_{m,t})h_t, \tag{1.9}$$

3. Factor markets are competitive, hence according to equations (3.2) and (2.3) the factor

prices are determined by their marginal products:

$$1 + r_t = \alpha A K_t^{\alpha-1}[(1 - l_{m,t})h_t]^{1-\alpha}, \tag{1.10}$$

$$w_t^h = (1 - \alpha)A K_t^{\alpha}[(1 - l_{m,t})h_t]^{-\alpha}, \tag{1.11}$$

4. Government expenditure per young individual on education is determined according to the following relationship:

$$E_t = \tau_t(1 - \alpha)y_t. \tag{1.12}$$

Since physical capital is completely depreciated and the migrant workers do not carry physical capital from the source country to the host country, expression (2.8) is the right equilibrium condition for this economy.[14]

1.3 Solving the model

Maximizing P1 with respect to c_{t+1}, e_{t+1}, b_{t+1} and $l_{m,t+1}$ gives the optimal consumption and optimal transfers, e_{t+1} and b_{t+1}, of generation t,

$$c_{t+1} = (1 - \theta - \mu)[(1 - \tau)(1 - l_{m,t+1})w_{t+1}^h h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1 + r_{t+1})], \tag{1.13}$$

$$e_{t+1} = \theta[(1 - \tau)(1 - l_{m,t+1})w_{t+1}^h h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1 + r_{t+1})], \tag{1.14}$$

$$b_{t+1} = \mu[(1 - \tau)(1 - l_{m,t+1})w_{t+1}^h h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1 + r_{t+1})], \tag{1.15}$$

and the following relationship:

$$\frac{\eta}{1 - l_{m,t+1}} = \frac{w^m h_{t+1} - (1 - \tau)w_{t+1}^h h_{t+1}}{[(1 - \tau)(1 - l_{m,t+1})w_{t+1}^h h_{t+1} + l_{m,t+1}w^m h_{t+1} + b_t(1 + r_{t+1})]}, \tag{1.16}$$

which at equilibrium determines the migration rate in period $t + 1$.

[14] Similar to Galor et al. (2009), in this model it is assumed that the parents care about the physical capital ownership of their offspring. Equilibrium condition (2.8) is analogous to the standard capital market equilibrium condition, namely that the aggregate savings in the current period are equal to the aggregate physical capital in the next period. The difference here is that the income allocation decision to physical capital is made by parents instead of the younger generation. As will be apparent later, the aggregate level of intergenerational transfers, b_{t+1}, is a fraction μ of the aggregate income in the period $t + 1$.

1.3.1 Aggregate income with migration

Substituting expressions (2.10) and (2.11) and using equilibrium condition (2.8) into (1.16) one obtains

$$[(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta]y_{t+1} = w^m h_{t+1} - (1+\eta)w^m l_{m,t+1} h_{t+1}, \tag{1.17}$$

solving for labor income in the host country:

$$w^m h_{t+1} = \frac{[(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta]}{1-(1+\eta)l_{m,t+1}} y_{t+1}. \tag{1.18}$$

Let $\tilde{I}_{t+1}$ be the aggregate income (total income generated in the source country plus labor income generated in the host country), after some algebraic manipulations, equilibrium conditions (2.10) and (1.14) and expressions (1.18) and (2.7) yield aggregate income with migration, $\tilde{I}_{t+1}$, as a function of income generated in the source country, y_{t+1}, and the migration rate, $l_{m,t+1}$:

$$\tilde{I}_{t+1} = \left[\frac{1-\tau(1-\alpha)-\alpha l_{m,t+1}}{1-(1+\eta)l_{m,t+1}}\right] y_{t+1}. \tag{1.19}$$

Notice that if $l_{m,t+1} = 0$ in (1.19), it simplifies to aggregate income of an economy without migration (closed economy). Hence, (1.19) summarizes the two main income sources in the labor-exporting countries, namely the labor income generated abroad by migrant workers and the income (labor and physical capital ownership) generated domestically by non-migrant agents.[15] The aggregate income, $\tilde{I}_{t+1}$, is indirectly associated, throughout $l_{m,t+1}$, with the host country real wages, w^m. This implicit association will be apparent below.[16]

[15] Notice that (1.19) can be written as $\tilde{I}_{t+1} = \left([1-\tau(1-\alpha)] + l_{m,t+1}\frac{[(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta]}{1-(1+\eta)l_{m,t+1}}\right) y_{t+1}$, where the first term inside the brackets is the proportion of income net of taxes generated by non-migrant agents and the second term is the proportion of income generated abroad by migrant workers.

[16] See expression (1.26). Henceforth, the expressions that depend on the migration rate, $l_{m,t+1}$, also indirectly depend on the host country real wages, w^m.

1.3.2 Physical capital and human capital

The aggregate level of intergenerational capital transfer in period t, as follows from (1.15) and using equilibrium conditions (2.8)-(2.11), is a fraction μ of the aggregate level of income $\tilde{I}_t$. The capital stock in period $t+1$, K_{t+1}, is therefore

$$K_{t+1} = \mu \left[\frac{1 - \tau(1-\alpha) - \alpha l_{m,t}}{1 - (1+\eta) l_{m,t}} \right] y_t, \tag{1.20}$$

which is independent of the migration rate in period $t+1$, but it depends on the migration rate in period t, in which the household decisions are made. The government's real expenditure on education per young individual in period t, E_t, is given by (2.12), whereas, as follows from (1.16) and using equilibrium conditions (2.8)-(2.11), the private investment in education, e_t, is a fraction θ of the aggregate level of income $\tilde{I}_t$. The private investment in education in the source country in period $t+1$ is hence

$$e_t = \theta \left[\frac{1 - \tau(1-\alpha) - \alpha l_{m,t}}{1 - (1+\eta) l_{m,t}} \right] y_t, \tag{1.21}$$

which is independent of the migration in period $t+1$, but dependent on the migration decision in period t. The key difference between this economy with migration (open economy) and an economy without migration (closed economy) is that while in a closed economy both the public expenditure on education, E_t, and the private investment in education, e_t, are correlated only with the aggregate income in period t, y_t, in an open economy the public education expenditure is correlated only with aggregate income generated in the source country, y_t, and the private investment in education is correlated with the aggregate income generated domestically, y_t, and with the migration rate, $l_{m,t}$.

The individual stock of human capital available in period $t+1$, h_{t+1}, is therefore

$$h_{t+1} = B \left[\theta \frac{1 - \tau(1-\alpha) - \alpha l_{m,t}}{1 - (1+\eta) l_{m,t}} \right]^{\delta} [\tau(1-\alpha)]^{1-\delta} y_t. \tag{1.22}$$

Notice that if $l_{m,t} = 0$ in (1.22), it simplifies to the law of motion of human capital of a closed economy.

1.3.3 Output and migration rate

As follows from (1.20) and (1.22), output in period $t+1$, $y_{t+1} = A(1-l_{m,t+1})^{1-\alpha}K_{t+1}^{\alpha}h_{t+1}^{1-\alpha}$, is

$$y_{t+1} = \tilde{A}\tau^{(1-\alpha)(1-\delta)}(1-l_{m,t+1})^{1-\alpha}\left[\frac{1-\tau(1-\alpha)-\alpha l_{m,t}}{1-(1+\eta)l_{m,t}}\right]^{\alpha+\delta(1-\alpha)} y_t, \tag{1.23}$$

where $\tilde{A} \equiv AB^{1-\alpha}\mu^{\alpha}\theta^{\delta(1-\alpha)}(1-\alpha)^{(1-\alpha)(1-\delta)}$. Notice that output, y_{t+1}, depends on the migration rate in period $t+1$, $l_{m,t+1}$. Hence, we need to find an expression of $l_{m,t+1}$ in terms of predetermined variables. As follows from (1.20) and (1.22), the individual physical-human capital ratio, $k_{t+1} \equiv K_{t+1}/h_{t+1}$, is

$$k_{t+1} = \tilde{B}\left[\frac{1-\tau(1-\alpha)-\alpha l_{m,t}}{[1-(1+\eta)l_{m,t}]\tau}\right]^{1-\delta}, \tag{1.24}$$

where $\tilde{B} \equiv \frac{\mu}{B\theta^{\delta}(1-\alpha)^{(1-\delta)}}$. Since $y_{t+1} = A(1-l_{m,t+1})^{1-\alpha}h_{t+1}k_{t+1}^{\alpha}$, (1.18) can be rewritten as:

$$\left[\frac{1-(1+\eta)l_{m,t+1}}{(1-l_{m,t+1})^{(1-\alpha)}}\right] = \left[\frac{(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta}{w^m}\right] Ak_{t+1}^{\alpha}. \tag{1.25}$$

Substituting (1.24) into (1.25), we find the relationship of the migration rate in period $t+1$ with the migration rate in period t

$$\left[\frac{1-(1+\eta)l_{m,t+1}}{(1-l_{m,t+1})^{(1-\alpha)}}\right] = \tilde{C}\left[\frac{1-\tau(1-\alpha)-\alpha l_{m,t}}{[1-(1+\eta)l_{m,t}]}\right]^{\alpha(1-\delta)}, \tag{1.26}$$

where $\tilde{C} \equiv \left[\frac{(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta}{w^m}\right]\frac{A\tilde{B}^{\alpha}}{\tau^{\alpha(1-\delta)}} \in (0,1)$. Equation (1.23) summarizes the direct relationship between the aggregate output and exogenous parameters and how it indirectly depends, through the migration rate given by (1.26), on exogenous parameters as well. Equation (1.26) summarizes how the migration rate in period $t+1$ implicitly depends upon

exogenous parameters and on the migration rate in period t. The next section analyzes these relationships at stationary competitive equilibrium.

1.4 Stationary competitive equilibrium

This section investigates the change in migration decisions and the stationary growth equilibrium when exogenous parameters change. In particular, it analyzes the role of the tax rate (public education policy), τ, the host country real wages, w^m, the preferences parameter, η, (preferences of living in the source country), the parents' degree of human capital altruism, θ, and the parents' degree of physical capital altruism, μ. A competitive equilibrium is stationary if the migration rate does not change over time and hence the prices of factors (i.e. physical capital and human capital) and the proportional allocations of the households' income between consumption and intergenerational transfers remain unchanged as well. In addition, given that the economy's aggregate production function and the production function of human capital exhibit constant return-to-scale technologies, the economy grows at a constant rate, γ. The first part of this section shows how the stationary equilibrium migration rate is determined and the relationship between this variable and the exogenous parameters of interest. The second part shows the relationship between the stationary equilibrium migration rate and the rest of the endogenous variables. Due to the fact that there is not a closed form solution for the equilibrium migration rate and that the algebraic expressions showing the relationships between the exogenous parameters and the economic growth rate may not be sufficiently informative (transparent), the next section shows these associations using numerical solutions.

1.4.1 Equilibrium migration rate

Lemma 1. *Provided that* $l_{m,t} \in [0, \frac{1}{1+\eta})$, *that* $\tau(1-\alpha) - \alpha l_{m,t} < 1 \ \forall t \geq 0$ *such that* $\tilde{I}_t > 0$ *and provided that* $\tilde{C} \in (0,1)$, *the fraction of migrant workers of the economy,* l_m^*, *is uniquely determined by expression (1.26):*

$$l_{m,t} = l_m^*(\tau, w^m, \eta, \mu, \eta, A),$$

where $\frac{\partial l_m^*}{\partial \tau} > 0$, $\frac{\partial l_m^*}{\partial w^m} > 0$, $\frac{\partial l_m^*}{\partial \eta} < 0$, $\frac{\partial l_m^*}{\partial \mu} < 0$, $\frac{\partial l_m^*}{\partial \theta} > 0$ *and* $\frac{\partial l_m^*}{\partial A} < 0$.

Proof. Substituting $l_{m,t+1} = l_{m,t} = l_m^*$ into (1.26), it follows that

$$\left[\frac{1-(1+\eta)l_m^*}{(1-l_m^*)^{(1-\alpha)}}\right] = \tilde{C}\left[\frac{1-\tau(1-\alpha)-\alpha l_m^*}{[1-(1+\eta)l_m^*]}\right]^{\alpha(1-\delta)}. \tag{1.27}$$

Now, (1.27) can be written

$$f(l_m^*) \equiv \frac{[1-(1+\eta)l_m^*]^{1+\alpha(1-\delta)}}{(1-l_m^*)^{(1-\alpha)}[1-\tau(1-\alpha)-\alpha l_m^*]^{\alpha(1-\delta)}} = \tilde{C}, \tag{1.28}$$

and since the left hand side of (1.28) is strictly decreasing in l_m^*, for each t there is a unique solution $l_{m,t} = l_m^*$ that satisfies (1.26) in equilibrium. Provided that $\tilde{C} \in (0,1)$ and $1 > (1+\eta)l_m^*$, the sufficient conditions for having a unique solution are that $\tau \in (0,1)$ and $\eta > 0$ (see appendix 1). Since $\frac{\partial \tilde{C}}{\partial \tau} < 0$, $\frac{\partial \tilde{C}}{\partial w^m} < 0$, $\frac{\partial \tilde{C}}{\partial \eta} > 0$, $\frac{\partial \tilde{C}}{\partial \mu} > 0$, $\frac{\partial \tilde{C}}{\partial \theta} < 0$ and $\frac{\partial \tilde{C}}{\partial A} > 0$, and additionally since $\frac{\partial f(l_m^*)}{\partial \tau} > 0$ and $\frac{\partial f(l_m^*)}{\partial \eta} < 0$, it follows from the Implicit Function Theorem that $\frac{\partial l_m^*}{\partial \tau} > 0$, $\frac{\partial l_m^*}{\partial w^m} > 0$, $\frac{\partial l_m^*}{\partial \eta} < 0$, $\frac{\partial l_m^*}{\partial \mu} < 0$, $\frac{\partial l_m^*}{\partial \theta} > 0$, and $\frac{\partial l_m^*}{\partial A} < 0$ (see appendix 1).■

1.4.2 Stationary prices of factors, consumption, intergenerational transfers and economic growth rate

This section shows the relationship between the stationary equilibrium migration rate and the rest of the endogenous variables: individual physical-human capital ratio, prices of factors, income allocations between consumption and intergenerational transfers, and economic growth rate. The individual physical-human capital ratio remains unchanged over time. As follows from (1.24), the individual physical-human capital ratio is constant over

time, $\frac{K_t}{h_t} \equiv k_t = k^*$. That is,

$$k^* = \tilde{B}\left[\frac{1-\tau(1-\alpha)-\alpha l_m^*}{[1-(1+\eta)l_m^*]\tau}\right]^{1-\delta}, \tag{1.29}$$

where $\tilde{B} \equiv \frac{\mu}{B\theta^{\delta}(1-\alpha)^{(1-\delta)}}$ and k^* is strictly decreasing in τ. There is both direct and indirect effect of τ on k^*. Noting (1.29), it is obvious that the direct effect of τ on k^* is negative. That is, when τ increases, it reduces the physical capital investments and, hence, it negatively affects the physical-human capital ratio. On the other hand, since $1 > \tau(1-\alpha)+\alpha/(1+\eta)$ for all $\tau \in (0,1)$, k^* is positively associated with l_m^* and, since l_m^* is positively related to τ, the indirect effect of τ on k^* is positive. This indirect effect works as follows: when τ increases, the prospective migrant workers are more likely to move from the low real wages country (the source country) to the high real wages country (the host country) and, therefore, the private investment in education and physical capital are encouraged by the migrants' higher labor income earned in the destination country. Therefore, indirectly this positively affects physical and human capital formation in the source country.

For the set of values of exogenous parameters such as those shown in the next section, the direct effect dominates the indirect effect and, hence, one might expect that k^* is strictly decreasing in τ. This result is qualitatively similar to the relationship between k^* and τ reported in comparable frameworks for a closed economy. The obvious difference between this economy and a closed economy (i.e. $l_m^* = 0$) is that the indirect effect for a closed economy does not exist because labor supply is fixed. Hence, one expects that any increase of τ would have a stronger negative effect on the physical-human capital ratio in a closed economy than in an open economy. When taxes increase, a larger fraction of prospective migrant workers will move to the host country (i.e. they escape the taxation burden) and only those with strong preferences for joining the local labor market would remain in the

source country. Thus, the negative effect of τ on k^* would be partially offset by the higher potential income of migrant workers in the destination country.

The prices of factors are uniquely determined and remain constant over time. From (2.10) and (2.11), it follows that

$$1 + r^* = \alpha A(1 - l_m^*)^{(1-\alpha)} k^{*-(1-\alpha)}, \tag{1.30}$$

$$w^{h^*} = (1 - \alpha)A(1 - l_m^*)^{-\alpha} k^{*\alpha}, \tag{1.31}$$

where k^* is given by expression (1.29). The proportions in the allocation of aggregate income between consumption, c_t, and intergenerational transfers, e_t and b_t, remain constant over time as well. As follows from (1.19), the aggregate income, $\tilde{I}_t$, is a constant proportion of domestically generated aggregate income, y_t, and noting equations (1.13)-(1.15), it follows:

$$c_t^* = (1 - \theta - \mu)\tilde{I}_t = (1 - \theta - \mu)\left[\frac{1 - \tau(1 - \alpha) - \alpha l_m^*}{1 - (1 + \eta)l_m^*}\right] y_t, \tag{1.32}$$

$$e_t^* = \theta\tilde{I}_t = \theta\left[\frac{1 - \tau(1 - \alpha) - \alpha l_m^*}{1 - (1 + \eta)l_m^*}\right] y_t, \tag{1.33}$$

$$b_t^* = \mu\tilde{I}_t = \mu\left[\frac{1 - \tau(1 - \alpha) - \alpha l_m^*}{1 - (1 + \eta)l_m^*}\right] y_t. \tag{1.34}$$

By the same token, these optimal allocations are negatively associated with τ. Finally, from (1.23), the economy grows at a constant rate $\gamma \equiv \frac{y_{t+1}}{y_t}$ as follows:

$$\gamma = \tilde{A}\tau^{(1-\alpha)(1-\delta)}(1 - l_m^*)^{1-\alpha}\left[\frac{1 - \tau(1 - \alpha) - \alpha l_m^*}{1 - (1 + \eta)l_m^*}\right]^{\alpha+\delta(1-\alpha)}, \tag{1.35}$$

where $\tilde{A} \equiv AB^{1-\alpha}\mu^{\alpha}\theta^{\delta(1-\alpha)}(1 - \alpha)^{(1-\alpha)(1-\delta)}$.

Notice that one cannot obtain a closed form solution for the prices of factors, for the income allocations between consumption and intergenerational transfers, and for the economic growth rate because the stationary equilibrium migration rate, l_m^*, does not have a closed form solution. However, using the Implicit Function Theorem one can characterize

the relationship between the exogenous parameters and the endogenous variables. Some exogenous parameters such as τ, θ, μ and η have a direct and an indirect effects on economic growth, whereas w^m only has an indirect effect through the migration rate, l_m^*. The direct effect is evident from a simple inspection of (1.35) and the indirect effect comes from the relationship between the economic growth rate, γ, and the migration rate shown by (1.35) and the relationship between the migration rate and exogenous parameters shown by (1.27). For instance, the direct effect of the labor income taxation rate, τ, on the economic growth rate is given by $\frac{\partial \gamma}{\partial \tau}$ and the indirect effect of τ on γ, applying the chain rule, is given by $\frac{\partial \gamma}{\partial l_m^*}\frac{\partial l_m^*}{\partial \tau}$. Hence, the total effect of τ on γ is given by $\frac{\partial \gamma}{\partial \tau} + \frac{\partial \gamma}{\partial l_m^*}\frac{\partial l_m^*}{\partial \tau}$. The same applies for the rest of the exogenous parameters, η, θ, μ, and w^m.

1.5 Calibration and computational analysis

This section provides numerical simulations to illustrate the relationships between exogenous parameters and both the stationary migration rate and the economic growth rate. The set of exogenous parameters is chosen so that the economic growth rate would be 4 percent annually for a closed economy (without migration) and so that the condition $l_m^* \in (0, 1/(1+\eta))$ is satisfied for an economy with migration. For the baseline model (closed economy), it is assumed that $\theta = 0.35$, $\mu = 0.35$, the capital's share of income is standard $\alpha = 0.4$, and $\tau = 0.20$ and the choices of the scale parameters A and B ensure a pre-migration economic growth rate of 4 percent per year.[17] The baseline value $\eta = 2$ is chosen so that the migration rate $l_m^* \in (0, 0.33)$, which replicates the data on migration for most of the developing countries.[18] As discussed by Glomm & Ravikumar (1998) and

[17] Here, it is assumed that the time-span of one generation is 30 years. Hence, one can alternatively say that the calibration yields an economic growth rate for a closed economy at the level of $(1.04)^{30}$ per generational period.

[18] See table 5.3 in Docquier & Marfouk (2006)

Blankenau & Simpson (2004), the appropriate value of $1-\delta$ is debatable. Estimates range from 0 (Coleman 1966) to 0.12 (Card & Kruger 1992). Loosely following Glomm & Ravikumar (1998), the strategy here is to explore three different values: $1-\delta = 0.05, 0.15$ and 0.25. We will, however, choose as a benchmark the case $1-\delta = 0.15$. Given the uncertainty about the preference parameters, a sensitivity analysis is carried out in order to show a better picture of the relationship between the economic growth rate and these parameters.

1.5.1 The equilibrium migration rate

The graphical analysis begins with figure (1.1), which illustrates the stationary migration rate for this economy, as established in Lemma 1. The left hand side of equation (1.28) is represented by the $f(l_m^*)$ curve, whereas the right hand side is represented by the horizontal lines, $\tilde{C}^A$ and $\tilde{C}^B$. The intersections of the $f(l_m^*)$ curve and the horizontal lines, $\tilde{C}^A$ and $\tilde{C}^B$, show the stationary equilibria migration rates, l_m^A and l_m^B, respectively. Figure (1.1) illustrates an exogenous change of the constant $\tilde{C}$, which might be, for example, a result of an exogenous change of the host country real wages. An exogenous increase of the host country migration real wages, w^m, implies that the constant $\tilde{C}$ declines from $\tilde{C}^A$ to $\tilde{C}^B$, and then the stationary equilibrium migration rate increases from l_m^A to l_m^B. The main numerical findings are discussed below.

1.5.2 The tax rate and the economic growth rate

From Lemma (1), the migration rate is increasing in τ. Given that the host country real wages are constant over time, when the taxation rate increases, the labor income net of taxes in the source country declines and, hence, more prospective migrant workers are likely to migrate. Figure (1.2) compares the relationship between growth and tax rates for a closed and an open economy. There are four main numerical findings associated with the effects

of τ on growth.

First, figure (1.2) shows that the growth rate for an open economy is higher than the growth rate for a closed economy. When taxes increase, a larger fraction of prospective migrants will move to the host country. Then, private transfers will increase and, consequently, private investments in human and physical capital will rise as well. As discussed above, even though the total effect of τ on the physical-human capital ratio and the private investment in education is negative for both economies (closed and open), the magnitudes of the negative effects of τ are lower for an open economy than for a closed economy. Hence, as shown by figure (1.2), the growth rate for an economy with migration is higher than the growth rate for an economy without migration at all levels of τ. This finding contrasts with the typical findings discussed in the literature on "brain drain".

Miyagiwa (1991) mentions two issues that have dominated the literature on "brain drain". The first is the welfare effects of migration. If the migration rate is sufficiently small in size, it does not affect the welfare of the residents in the source country, but a finite level of emigration is welfare-reducing to those left behind. The second issue is the identification of the appropriate policies to compensate for the welfare losses suffered by the non-migrant workers. This is the Bhagwati's proposal, which calls for income transfers via taxation from the skilled migrants living in developed countries to those left behind. As noted in this paper, private transfers from migrants toward non-migrants may play the role of the income transfers via taxation proposed by Bhagwati, encouraging economic growth in the economy with migration and, therefore, reducing, or even reversing, the negative effect suggested by the "brain drain" literature.

As an illustrative case, however, this paper also can reproduce an economy in which exposure to international migration negatively affects growth as typically suggested by

the literature on "brain drain". This is possible when both the contribution of private investment to human capital formation and migration costs are too low (i.e. $\delta = 0.1$ and $\eta = 0.1$) so that the migration rate is sufficiently high.[19] If the migration rate is too high (due to the low migration costs, η is almost zero), the loss of tax revenues is significantly large. The loss of tax revenues, combined with the fact that the education is subsidized, yields an economic growth rate for an economy with migration that is lower than that for an economy without migration at all levels of $\tau \in (0, 0.99)$. Hence, if the contribution of government expenditure on education to human capital formation is too high (0.90), migration also exports the returns on this public investment.

Second, the economic growth rate is nonmonotonically associated with τ (government expenditure on education). The relationship between the migration rate and the tax rate is an expected finding, whereas the relationship of growth with government expenditure on education might not be an obvious result.

Empirical evidence of the effects that government expenditure on education has on economic growth using macro-level data is mixed.[20] A theoretical study by Blankenau & Simpson (2004), which develops a framework similar to that developed in this paper for a closed economy, shows that the positive direct effect of public education spending on growth can be diminished, or even negated, when other determinants of growth (i.e. the physical-human capital ratio and private investment in education) are negatively affected by general equilibrium adjustments.

[19] Notice that the value assumed for δ in this case is significantly lower than that found by Coleman (1966) and Card & Kruger (1992), between 0.88 and 1. Therefore, this experiment is just an instructive example. The figure for this case is not reported in the paper.

[20] Blankenau et al. (2007), among others, using panel data from 23 developed countries over the period 1960-2000, find a positive relationship between public education expenditures and growth only when controlling for the government budget constraint. Barro & Sala-i Martin (1999) also find a positive relationship between government education spending and growth. Easterly & Rebelo (1993) find a positive effect of government education expenditure on growth only for some specifications, while Levine & Renelt (1992) conclude that government education expenditures are not robustly correlated with growth rates.

Similar to the Blankenau & Simpson (2004) setting (i.e. $l_m^* = 0$), in this framework growth depends on public education expenditures as a share of output, the physical-human capital ratio and per capita private investment in human capital. When taxes are used to finance public education, government expenditure on public education unambiguously lowers both the physical-human capital ratio and the private investment in education.[21] The crowding out of physical capital and private investment in education diminishes and even reverses the positive direct effect of public education expenditures on growth. In general, the direct effect of τ on growth depends only on the relative contribution of government expenditures to the overall human capital formation (i.e. $1-\delta$, in this paper), whereas the indirect effects of τ on growth, throughout the physical-human capital ratio and the private investment in human capital, vary with the level of government expenditures, the method of finance expenditures and the rest of the exogenous parameters.

Hence, for low levels of government expenditure on education (i.e. low tax rates), there is not enough human capital in the economy, whereas for high levels of government expenditure on education there is not sufficient physical capital in the economy. The findings for a closed economy are shown by the dashed curve of figure (1.2) for three different values of $1-\delta$. Panels (a), (b) and (c) correspond to $1-\delta = 0.05$, $1-\delta = 0.15$, and $1-\delta = 0.25$, respectively. The three cases show that for low levels of government expenditure on education the economic growth rate is increasing in τ and for relatively high levels of government expenditures growth is decreasing in τ. The values of τ that maximize growth rates are $\tau^* = 0.05$, $\tau^* = 0.15$ and $\tau^* = 0.25$ for panels (a), (b) and (c), respectively.[22]

[21] If $l_m^* = 0$, a simple inspection of (1.29) and (1.33) shows this negative association.

[22] Notice that in this paper, if $l_m^* = 0$, then from (1.35) the efficient government expenditure on education in an economy without migration is $\tau^* \equiv \arg\max \gamma = \frac{\partial \gamma}{\partial \tau} = 1-\delta$. An equivalent expression can be obtained from (1.35) if $l_m^* > 0$, but it would be a complicated expression because l_m^* depends on τ as well (see appendix 1). Hence, we use here calibration to determine the efficient government expenditure on education.

Third, the growth-maximizing tax rate (efficient level of government expenditure) is lower for an economy without migration than for an economy with migration when exposure to international migration positively affects growth. Even though the nonmonotonic relationship between growth and τ is qualitatively similar for both a closed and an open economy, the quantitative results differ between both economies.[23] For an open economy, figure (1.2) shows that growth is increasing in τ even for relatively high values of τ. The values of τ that maximize the growth rate are significantly higher for an open economy (τ^{**}) than those for a closed economy (τ^{*}). As follows from figure (1.2), the values of τ^{**} that maximize the economic growth for an open economy are equal to 0.70, 0.77 and 0.81, when $1-\delta$ is equal to 0.05, 0.15 and 0.25, respectively. Therefore, for low levels of government expenditure on education (i.e. low tax rates), there is still not enough human capital (but higher than in the closed economy), whereas for high levels of government expenditure on education there is still not sufficient physical capital (but higher than in the closed economy). If exposure to international migration positively affects economic growth in the source country, the level of efficient government expenditure on education in an open economy is higher than the level of efficient expenditure on public schooling in a closed economy.

Finally, the lower the preference for joining the labor market in the source country ("subjective" migration costs), η, the lower the growth-maximizing tax rate (efficient level of government expenditure). High taxes encourage migration and only those with strong preferences for joining the local labor market (i.e. high η) will stay in the source country. Figure (1.3) shows the relationship between the economic growth rate and the tax rate for three different values of η. The "subjective" migration cost, η, is equal to 5, 2 and 0.10

[23] The level of expenditure on public schooling that maximizes the stationary equilibrium economic growth rate in the source country is $\tau^{*} \equiv \arg\max \gamma = \frac{\partial \gamma}{\partial \tau} + \frac{\partial \gamma}{\partial l_m^{*}} \frac{\partial l_m^{*}}{\partial \tau}$.

for the figures of panel (a), panel (b) and panel (c), respectively. Since the migration rate is increasing in τ, these calibrations yield strictly increasing equilibrium migration rates between 5 and 13.2% when $\eta = 5$, between 21.7 and 30.3% when $\eta = 2$ and between 87.6 and 90.7% when $\eta = 0.1$. The values of τ that maximize the economic growth rates are equal to 0.9, 0.82 and 0.59 when the values of η are 5, 2 and 0.10, respectively. Hence, the efficient level of government expenditure is positively associated with η. This might suggest that the easier it is to escape from the taxes of the source countries the higher is the cost in terms of taxation revenue when taxation rates increase for these countries. This, then, would lower the optimal taxation rate.

1.5.3 The migrants' wages, the parents' degree of altruism and the economic growth rate

Recall that migrants move to a higher wage country, where immigrants from their particular source country represent only a small fraction of the total population and hence are unable to affect real wages in the host country. Figure (1.4) shows that both the migration and the economic growth rate are positively correlated with w^m. A higher migration rate implies that private investment in human capital and physical-human capital increases in w^m as well.

While the migration rate is positively associated with the parents' degree of human capital altruism, θ, it is negatively correlated with the parents' degree of physical capital altruism, μ. The migration rate is positively correlated with the parents' degree of human capital altruism because, in this economy, the migrant workers are allowed to carry the human capital acquired in the source country when young to a country with higher human capital return when older. But, migrant workers are not allowed to carry physical capital.[24]

[24]Most of the migrant workers from Mexico, Central America and the Caribbean countries to the U.S. do not carry any physical capital.

Since a higher degree of the parents' physical capital altruism implies greater physical capital inherited by the children and, hence, higher income from physical capital ownership in the source country when older, a lower migration rate is implied.

Figure (1.5) and figure (1.6) show those relationships. Figure (1.5) shows that the economic growth rate is an increasing function of the parents' degree of human capital altruism, θ. When θ increases, the private investment in human capital increases. Since migration is positively associated with θ and potential migrants move to a country with higher human capital return, physical capital investment grows as well. Notice from (1.35) that there are two effects of θ on γ, namely a direct effect and an indirect effect through l_m^*. The direct effect of θ on γ is a positive effect. For standard values of τ and α, as those used to compute figure (1.5), the migration rate is positively associated with the economic growth rate. Since the migration rate is also positively associated with θ (see appendix 1), it follows that the indirect effect of θ on γ is positive as well. Figure (1.6), as expected, shows that the economic growth level is also an increasing function of the parents' degree of physical capital altruism, μ.

1.5.4 The "subjective" migration costs and the economic growth rate

Even though there is a large gap in potential labor income between the source countries and the developed countries, the observed data on migration show relatively low migration rates for most of the developing countries.[25] Hence, the "subjective" migration cost parameter, η, may play a major role in the decision to migrate.[26] The numerical exercise in this section

[25] See Lucas (2005) for a further discussion and see Docquier & Marfouk (2006) for the observed data on migration. According to Docquier & Marfouk (2006), the migration rate of Caribbean, Central American and South American countries is 15.3, 11.9 and 1.6 percent, respectively.

[26] The "subjective" migration cost, η, can be thought of as a more general migration costs definition, which may include financial costs and any cost imposed by the immigration policies of the destination countries such as visa requirements, border enforcement, restrictions on health and education services for immigrants, etc.

shows how the migration rate and the economic growth rate are driven in this model by η for different contributions of private education to overall production of human capital in the source countries.

As follows from Lemma (1), the migration rate is negatively associated with η and, as follows from figure (1.7), the economic growth rate is nonmonotonically correlated with this parameter. Although the relationship between the migration rate and η is as expected, the relationship of growth and η may not be so obvious. The "subjective" migration costs, η, affect economic growth through private investment in education, the physical-human capital ratio and the migration rate.[27] For low levels of migration induced by relatively high levels of migration costs (i.e. η), the indirect effect of η on economic growth, through private investment in education and the physical-human capital ratio, dominates so that growth increases in η. In contrast, when migration costs are relatively low (i.e. the migration rate becomes sufficiently high), the negative effects, through the migration rate, on economic growth are large enough to offset the positive effect so that the growth rate falls in η.[28] Hence, there is a range of relatively low values of η (i.e. high levels of migration) in which the economic growth rate of an economy with migration is decreasing in η. As follows from (1.7), the values of η that maximize the economic growth rate are 0.03, 0.12 and 0.21 when the values of $1-\delta$ are 0.95, 0.85 and 0.75, respectively.

Provided that the migration rate is sufficiently high, the lower the contribution of private investment in education to human capital accumulation, the higher the likelihood that exposure to international migration negatively impacts economic growth in the source country. If, as Bhagwati proposed more than thirty years ago, the migrants' labor income were

[27] Notice from (1.29) and (1.33) that $\frac{\partial k^*}{\partial \eta} > 0$ and $\frac{\partial e^*}{\partial \eta} > 0$ and, since $\frac{\partial k^*}{\partial l_m^*}\frac{\partial l_m^*}{\partial \eta} < 0$ and $\frac{\partial e^*}{\partial l_m^*}\frac{\partial l_m^*}{\partial \eta} < 0$, the total effect of η on k^* and e^* is ambiguous.

[28] Notice that if η is sufficiently large, the equilibrium rate tends to zero and the economic growth rate is similar to that for a closed economy.

taxed, the negative impact on economic growth would not occur in this economy. If the government were allowed to collect taxes from the migrant workers, the expenditure on public education would be higher in the source country and, therefore, non-migrant workers would always be better off. However, as noted by Wilson (2008), the major obstacle to the implementation of Bhagwati's proposal to allow developing countries to tax migrants residing in developed countries is the administrative problems associated with collecting this tax in the absence of the developed countries' cooperation.

Summing up, if private transfers are allowed, exposure to international migration is more likely to encourage economic growth in the labor-exporting countries only if the contribution of private investment in education to the overall production of human capital is not too low and the migration rate is not too high. Given the observed data on migration rates (i.e. from Mexico, Central America and Caribbean countries to the U.S.) and the contribution of private investment in education to human capital formation, there is a potential gain in economic growth for developing countries if developed countries tend to relax immigration policies as predicted by Özden & Schiff (2006).[29]

1.6 Conclusions and final comments

This paper developed an endogenous growth model with intergenerational transfers and international migration to investigate how exposure to international migration affects physical-human capital formation and, hence, economic growth in the source countries. Migrants

[29] Özden & Schiff (2006) suggest that the imbalance between demographic trends in developed countries and developing countries might allow the relaxation of immigration policies in developed countries in the future and this points toward significant potential economic gains from migration. They point out that "the labor forces in many developed countries are expected to peak around 2010 and decline by around 5 percent in the following two decades, accompanied by a rapid increase in dependency ratios. Conversely, the labor forces in many developing countries are expanding rapidly, resulting in declines in dependency ratios." The authors continue: "For instance, it has been estimated that an increase in the number of migrants equal to 3 percent of the labor force of the Organization for Economic Co-operation and Development (OECD) countries would result in global welfare gains that surpass those obtained from the removal of all trade barriers, with significant gains for all parties involved". Also see Walmsley & Winters (2005).

move to a higher wage country, where immigrants from their particular source country represent only a small fraction of the total population and hence are unable to affect real wages in the host country. The migrants do not carry physical capital from the source country to the host country. The human capital technology depends on private investment in, and real government expenditure on, education. Individuals behave altruistically toward their children and derive utility of living in the source country when older. The preference for joining the labor force in the source country captures the fact that workers are likely to have a preference for the country of their origin life-style because of cultural factors, family relationships, and so on.

Numerical simulations illustrated the relationships between exogenous parameters and the stationary migration rate and economic growth rate, in which were used reasonable values of the preference parameters and the parameters of the human capital and production functions. The main findings from comparative statics are as follows: (i) the migration rate is strictly increasing in the labor income taxation rate, whereas the economic growth rate is nonmonotonically associated with this parameter; (ii) the migration rate is strictly decreasing in the preference for joining the labor market in the source country, while the economic growth rate is nonmonotonically correlated with that parameter; (iii) both the migration and the economic growth rates are strictly increasing in the host country real wages; (iv) both the migration rate and economic growth are strictly increasing in the parents' degree of human capital altruism; and (v) while the migration rate is strictly decreasing in the parents' degree of physical capital altruism, economic growth is strictly increasing in it.

Some particular results in this paper require a comprehensive analysis of the relationships between economic growth and the critical parameters, the preference for joining the

labor market in the source country and the contribution of private investment in education to the human capital formation in the source county. This paper might be the first attempt to understand the association between migration and the way of financing the human capital of migrant workers in the source countries. If private transfers are allowed, exposure to international migration is more likely to encourage economic growth in the labor-exporting countries only if the contribution of private investment in education to human capital formation is not too low and the migration rate is not too high. Given the observed data on migration rates and the contribution of private investment in education to human capital formation, there is a potential gain in economic growth for developing countries if developed countries tend toward the relaxation of immigration policies.

Since in the analytical model of this paper individuals within, as well as across, generations are identical in their preferences and innate abilities, the results might change if one assumes heterogeneity in innate abilities. The findings would critically depend on whether it is assumed that high or low-skilled workers are more likely to emigrate. If high (low) skilled workers are more likely to emigrate, then the likelihood of adverse economic consequences may be magnified (contracted) due to the fact that the government expenditure on education per student would decrease (increase).

An extension of the theoretical analysis developed in this paper would be to assume a small open economy with perfect capital mobility. Since labor taxes are not a relatively important source of government revenue in labor-exporting countries, future work would also include a wider range of taxes such as the value added and tariffs. These taxes are much more important than labor taxes in non-OECD countries. The results in this paper might be affected if, instead of assuming a log utility function and a Cobb-Douglas human capital technology, one assumes a more general specification for those functions. Therefore, the

results should be read taking into account the potential limitation of those specifications. Here, research is required.

Appendix 1

Let us rewrite equation (1.28) as follows:

$$[1+\alpha(1-\delta)]\log[1-(1+\eta)l_m^*]-(1-\alpha)\log(1-l_m^*)-\alpha(1-\delta)\log[1-\tau(1-\alpha)-\alpha l_m^*]=\log\tilde{C}, \tag{1.36}$$

where $\log\tilde{C}=\log[(1+\eta)(1-\tau)(1-\alpha)+\alpha\eta]-\log w^m+\log A+\alpha[\log\mu-\log B-\delta\log\theta-(1-\delta)\log(1-\alpha)]-\alpha(1-\delta)\log\tau$.

From the derivative of (1.36) with respect to l_m^* one can obtain

$$\frac{1-\alpha}{1-l_m^*}+\frac{\alpha^2(1-\delta)}{1-\tau(1-\alpha)-\alpha l_m^*}-\frac{[1+\alpha(1-\delta)](1+\eta)}{1-(1+\eta)l_m^*}\lessgtr 0. \tag{1.37}$$

Rewriting (1.37), we get

$$\frac{1-\alpha}{1-l_m^*}+\frac{\alpha^2(1-\delta)}{1-\tau(1-\alpha)-\alpha l_m^*}-\frac{\alpha(1-\delta)(1+\eta)}{1-(1+\eta)l_m^*}\lessgtr\frac{(1+\eta)}{1-(1+\eta)l_m^*}, \tag{1.38}$$

$$\frac{1-\alpha}{1-l_m^*}+\left[\frac{\alpha}{1-\tau(1-\alpha)-\alpha l_m^*}-\frac{(1+\eta)}{1-(1+\eta)l_m^*}\right]\alpha(1-\delta)\lessgtr\frac{(1+\eta)}{1-(1+\eta)l_m^*}, \tag{1.39}$$

$$\frac{1-\alpha}{1-l_m^*}+\left[\frac{\alpha-[1-\tau(1-\alpha)](1+\eta)}{[1-\tau(1-\alpha)-\alpha l_m^*][1-(1+\eta)l_m^*]}\right]\alpha(1-\delta)\lessgtr\frac{(1+\eta)}{1-(1+\eta)l_m^*}. \tag{1.40}$$

Then, multiplying both sides of (1.40) by $1-(1+\eta)l_m^*$,

$$\frac{(1-\alpha)[1-(1+\eta)l_m^*]}{1-l_m^*}+\left[\frac{\alpha-[1-\tau(1-\alpha)](1+\eta)}{[1-\tau(1-\alpha)-\alpha l_m^*]}\right]\alpha(1-\delta)\lessgtr(1+\eta), \tag{1.41}$$

dividing both sides of (1.41) by $1+\eta$ and subtracting the first term of the LHS from both sides, one gets

$$\left[\frac{\alpha/(1+\eta)+\tau(1-\alpha)-1}{[1-\tau(1-\alpha)-\alpha l_m^*]}\right]\alpha(1-\delta)\lessgtr 1-\frac{(1-\alpha)[1-(1+\eta)l_m^*]}{(1-l_m^*)(1+\eta)}. \tag{1.42}$$

Now, since $\tau\in(0,1)$, $\eta>0$ and $1>(1+\eta)l_m^*$, (1.42) can be written as a strict inequality as follows:

$$\left[\frac{\alpha/(1+\eta)+\tau(1-\alpha)-1}{[1-\tau(1-\alpha)-\alpha l_m^*]}\right]\alpha(1-\delta)<\frac{[1-(1+\eta)l_m^*]\alpha+\eta}{(1-l_m^*)(1+\eta)}. \tag{1.43}$$

Since the RHS of (1.43) is always positive and the LHS is always negative, it follows that $f(l_m^*)$ is strictly decreasing with respect to l_m^*. Using the Implicit Function Theorem to obtain the relationship of the exogenous parameters of interest, τ, w^m, η, θ and μ, and the equilibrium migration rate, l_m^*, from (1.36) we obtain

$$\frac{\partial l_m^*}{\partial \tau} = \phi_1/\varphi > 0, \tag{1.44}$$

$$\frac{\partial l_m^*}{\partial w^m} = \phi_2/\varphi > 0, \tag{1.45}$$

$$\frac{\partial l_m^*}{\partial \eta} = \phi_3/\varphi < 0, \tag{1.46}$$

$$\frac{\partial l_m^*}{\partial \theta} = \phi_4/\varphi > 0, \tag{1.47}$$

$$\frac{\partial l_m^*}{\partial \mu} = \phi_5/\varphi < 0, \tag{1.48}$$

$$\frac{\partial l_m^*}{\partial A} = \phi_6/\varphi < 0,$$

where, from (1.37) we get:

$$\varphi \equiv \frac{1-\alpha}{1-l_m^*} + \frac{\alpha^2(1-\delta)}{1-\tau(1-\alpha)-\alpha l_m^*} - \frac{[1+\alpha(1-\delta)](1+\eta)}{1-(1+\eta)l_m^*} < 0,$$

$$\phi_1 \equiv -\frac{(1+\eta)(1-\alpha)}{(1+\eta)(1-\alpha)(1-\tau)+\alpha\eta} - \frac{\alpha(1-\delta)}{\tau} - \frac{\alpha(1-\delta)(1-\alpha)}{1-\tau(1-\alpha)-\alpha l_m^*} < 0,$$

$$\phi_2 \equiv -\frac{1}{w^m} < 0,$$

$$\phi_3 \equiv \frac{(1-\alpha)(1-\tau)+\alpha}{(1+\eta)(1-\alpha)(1-\tau)+\alpha\eta} + \frac{[1+\alpha(1-\delta)]l_m^*}{1-(1+\eta)l_m^*} > 0,$$

$$\phi_4 \equiv -\frac{\alpha\delta}{\theta} < 0,$$

$$\phi_5 \equiv \frac{\alpha}{\mu} > 0,$$

$$\phi_6 \equiv \frac{1}{A} > 0.$$

Figure 1.1: Migration Rate at Equilibrium

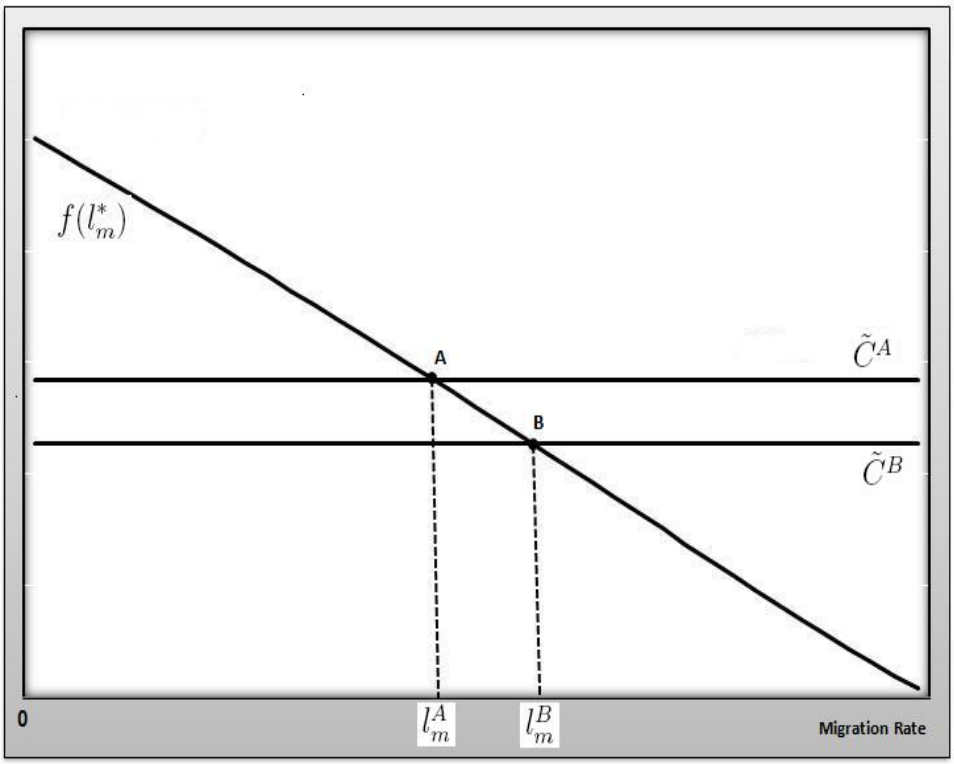
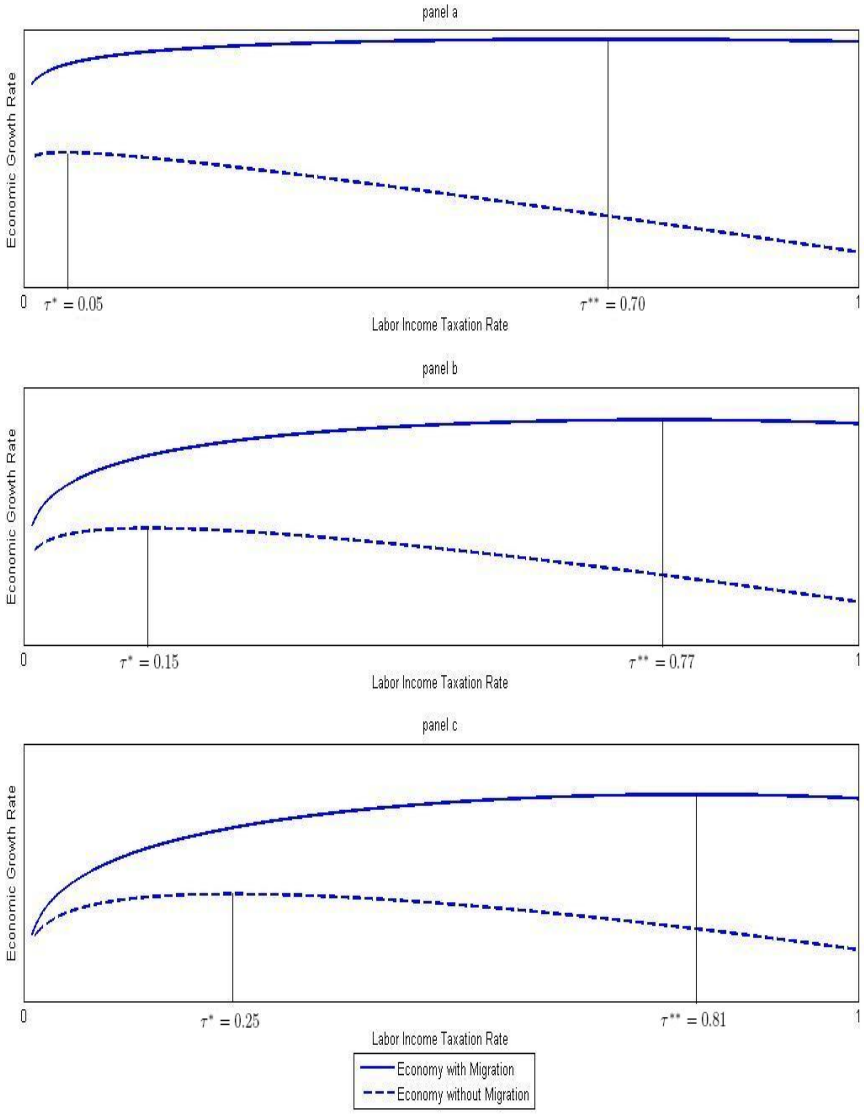
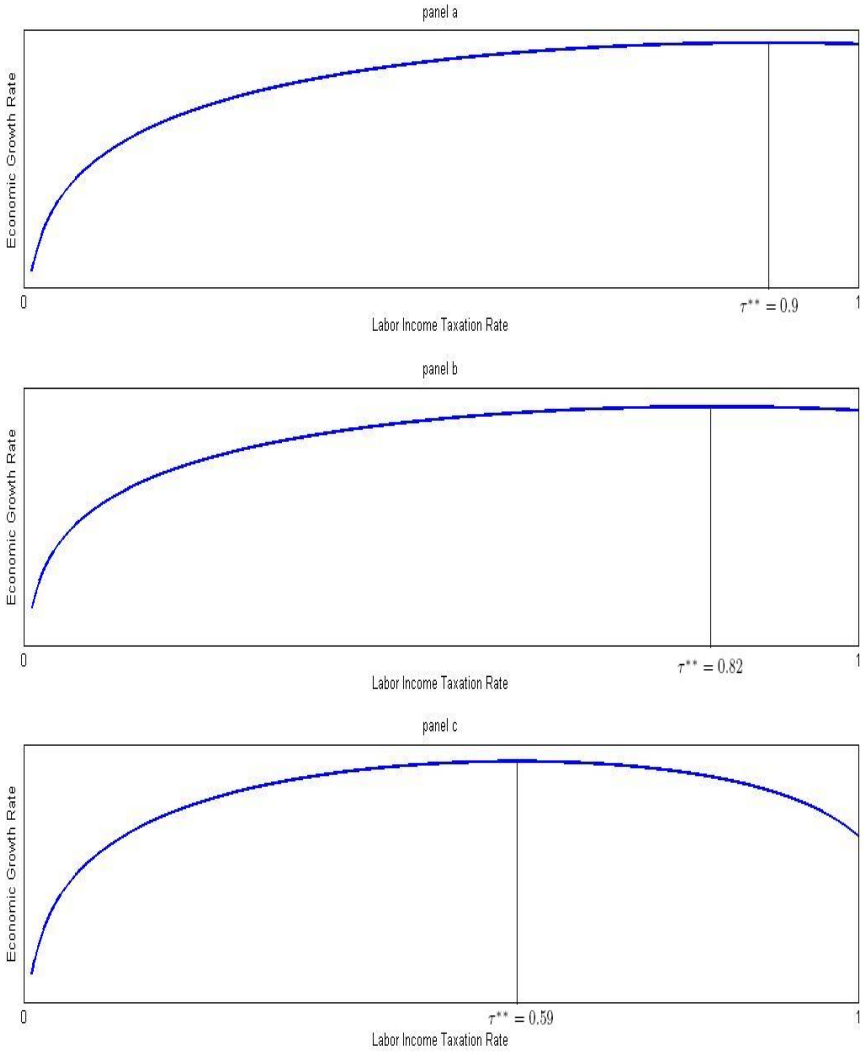


Figure 1.2: Labor Income Tax Rate Effect on Economic Growth for Different Values of the Contribution of Private Investment in Education (δ) to Human Capital Formation



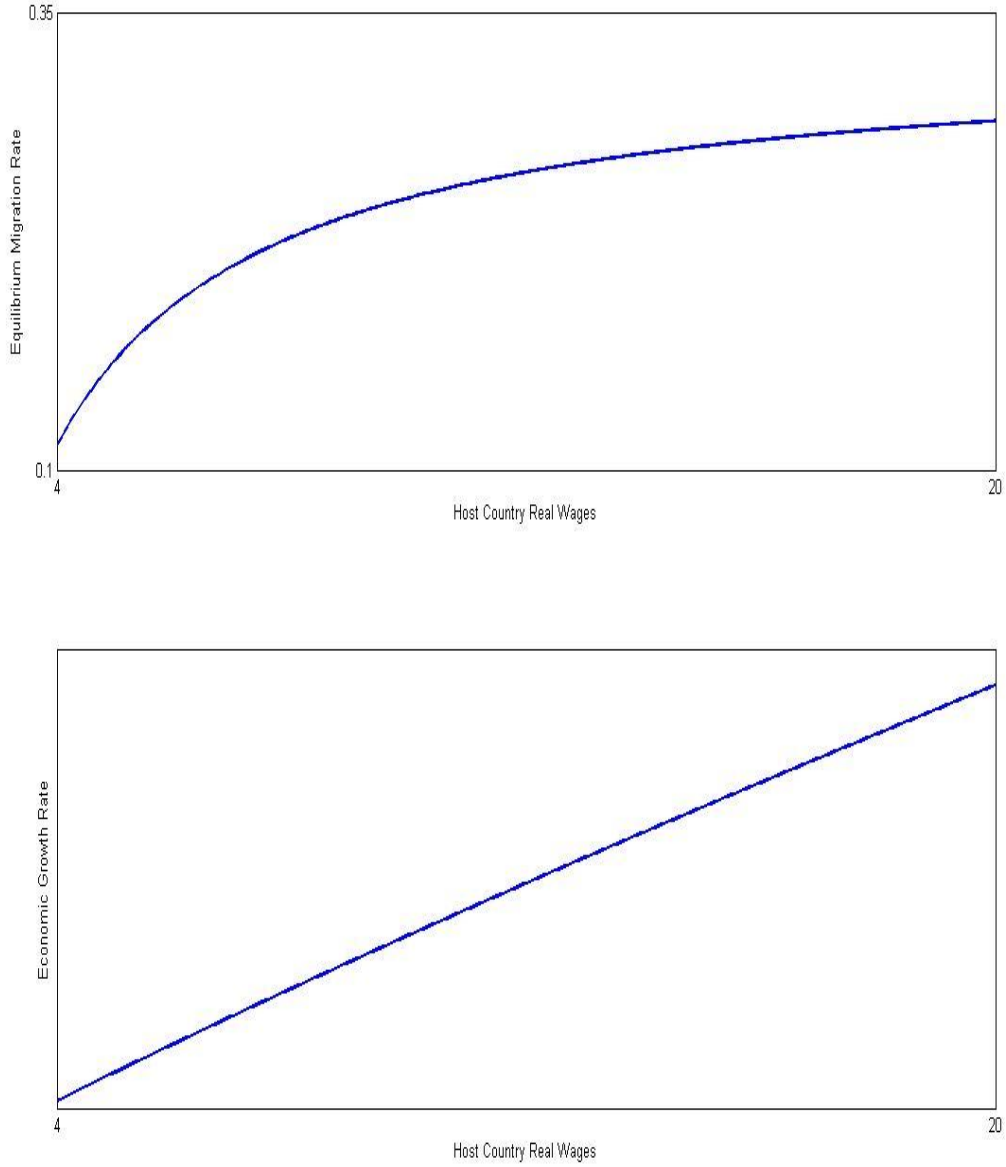
Calibration: $\tau \in [0.01, 0.99]$, $\theta = 0.35$, $\mu = 0.35$, $\alpha = 0.4$, $\eta = 1.5$ and the scale parameters are $A = 2.88$, $B = 10$ and $w^m = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/1+\eta)$. Thus, the maximum attainable migration rate is 40%. The contribution of private investment in education, δ, is equal to 0.95, 0.85 and 0.75 for the figures of panel (a), panel (b) and panel (c), respectively. This calibration yields a strictly increasing equilibrium migration rate between 16.4 and 25% for panel (a), between 10.9 and 33.7% for panel (b) and between 4.6 and 33% for panel (c), and an economic growth rate for a closed economy at the level of 4% per year if $\tau = 0.2$ and $\delta = 0.85$.

Figure 1.3: Labor Income Tax Rate Effect on Economic Growth for Different Values of the "Subjective" Migration Costs (η)



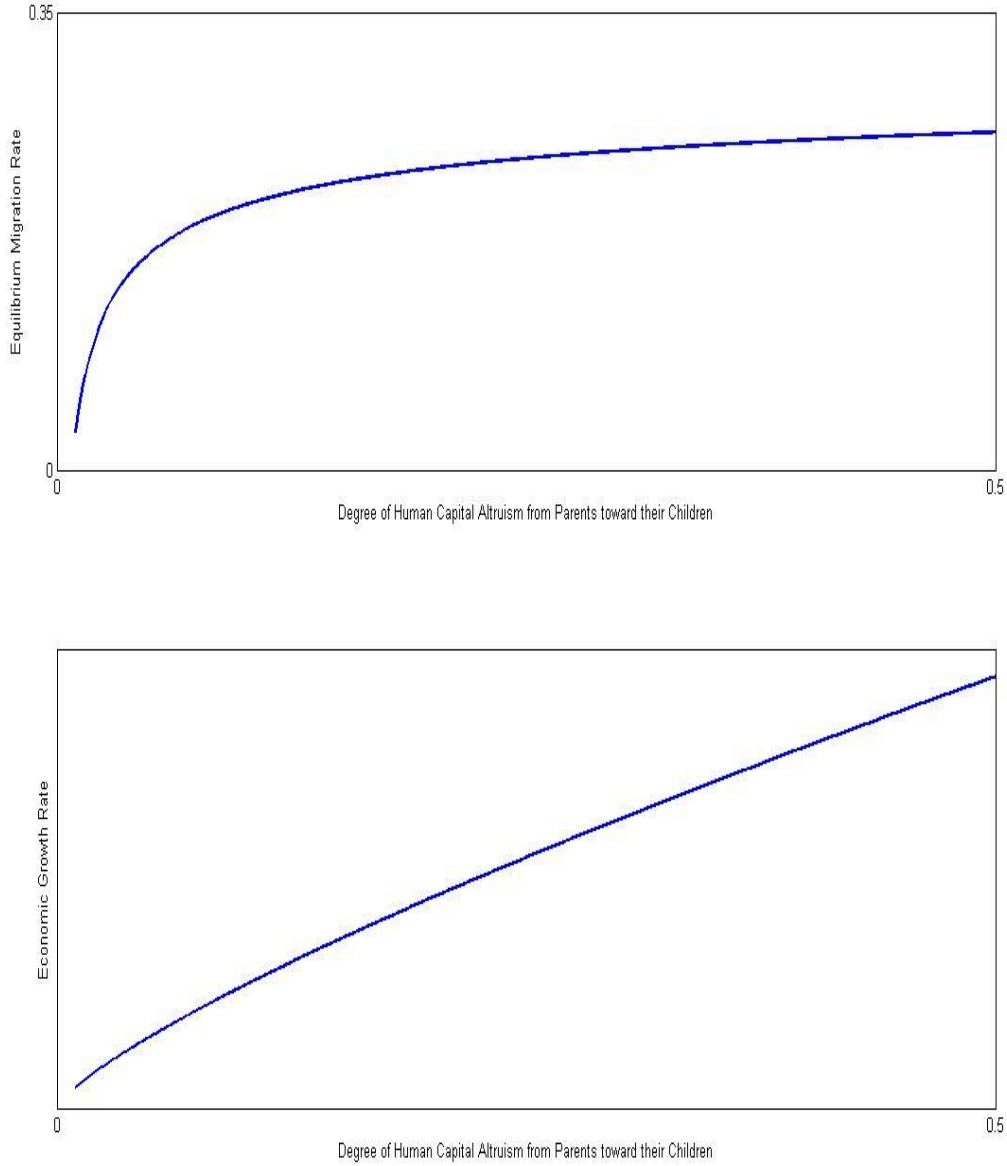
Calibration: $\tau \in [0.01, 0.99]$, $\theta = 0.35$, $\mu = 0.35$, $\delta = 0.85$, $\alpha = 0.4$, and the scale parameters are $A = 2.9$, $B = 20$ and $w^m = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/1 + \eta)$. The "subjective" migration cost, η, is equal to 5, 2 and 0.10 for the figures of panel (a), panel (b) and panel (c), respectively. This calibration yields a strictly increasing equilibrium migration rate between 5 and 13.2% for panel (a), between 21.7 and 30.3% for panel (b) and between 87.6 and 90.7% for panel (c), and an economic growth rate for a closed economy at the level of 4% per year if $\tau = 0.2$ and $\delta = 0.85$.

Figure 1.4: Host Country Real Wages Effect on Equilibrium Migration Rate and Economic Growth Rate



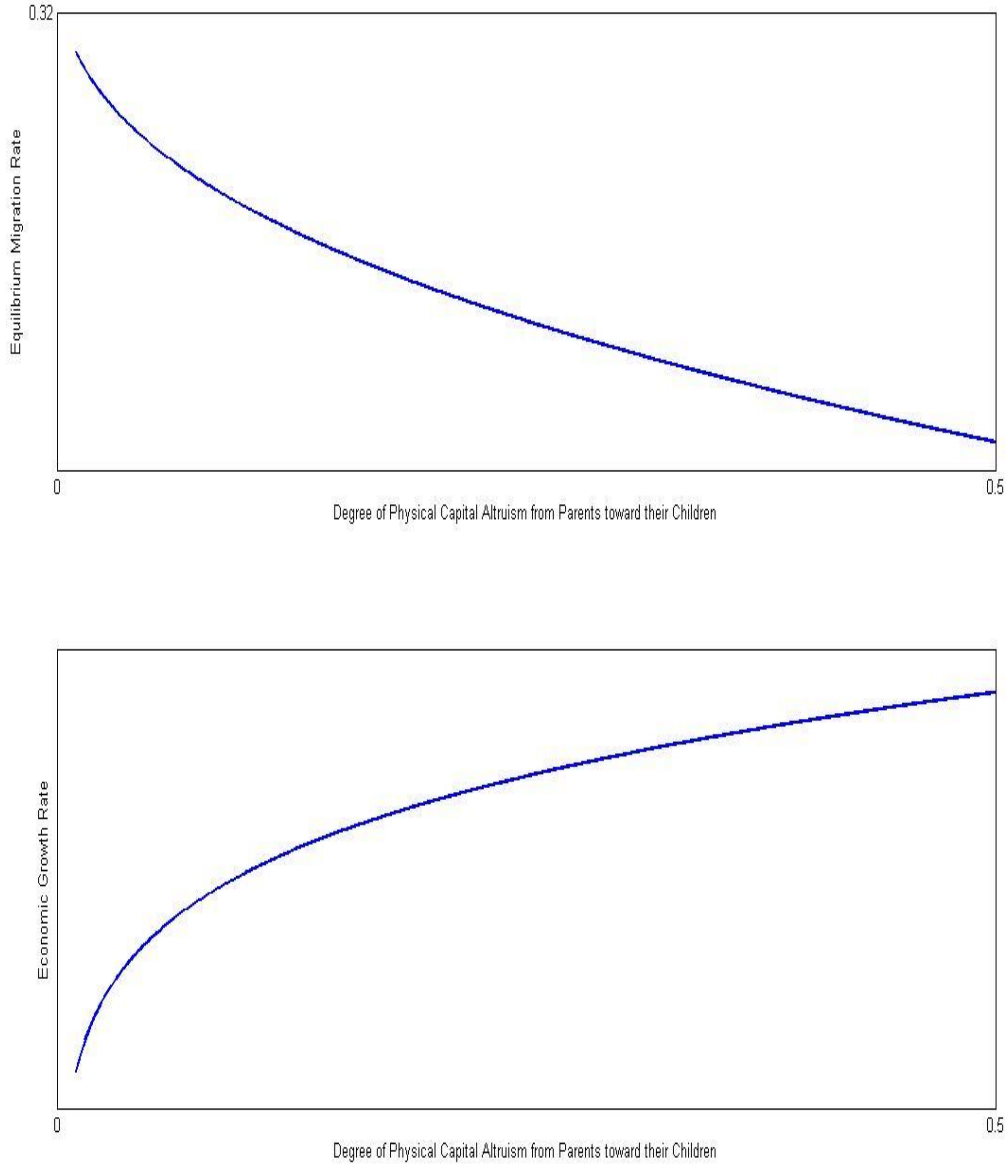
Calibration: $w^m \in [4, 20]$, $\tau = 0.2$, $\theta = 0.35$, $\mu = 0.35$ $\delta = 0.85$, $\alpha = 0.4$, $\eta = 2.0$, and the scale parameters are $A = 2.88$, and $B = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/1 + \eta)$. Thus, the maximum attainable migration rate is 33.3%. This calibration yields a strictly increasing equilibrium migration rate between 11.3 and 29.1% and an economic growth rate for a closed economy at the level of 4% per year.

Figure 1.5: Degree of Human Capital Altruism Effect on Equilibrium Migration Rate and Economic Growth Rate



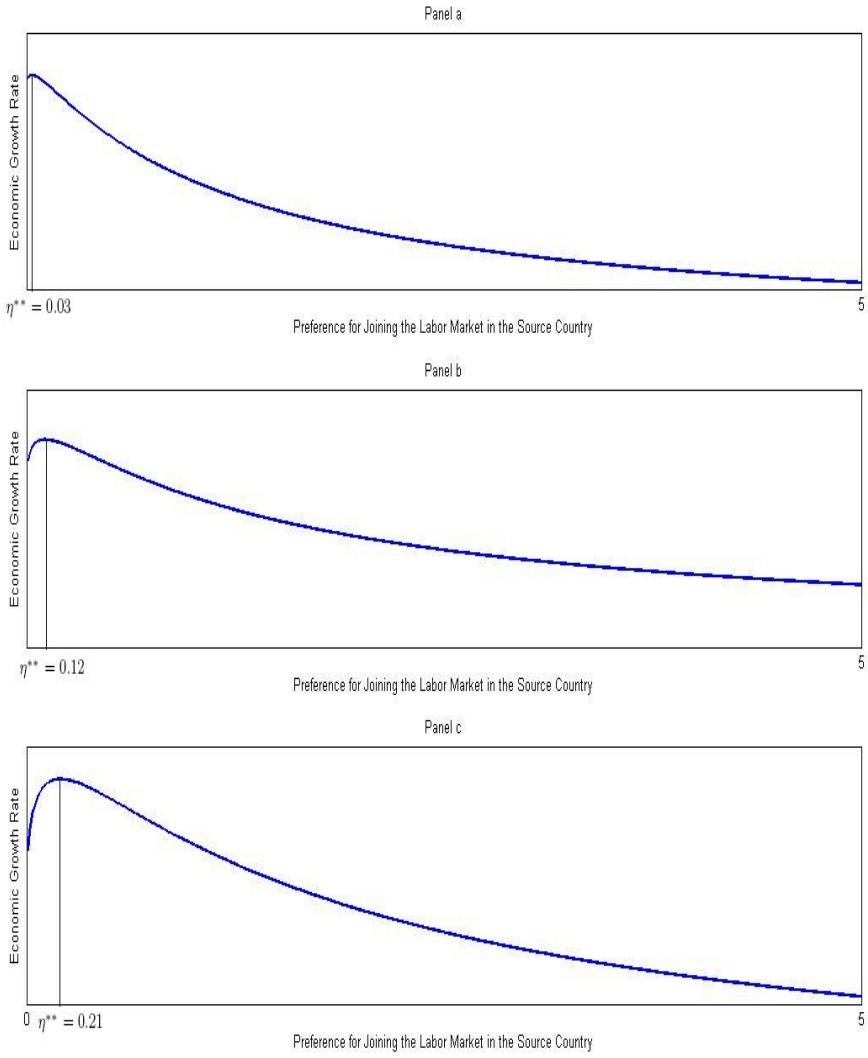
Calibration: $\theta \in [0.01, 0.5]$, $\tau = 0.2$, $\mu = 0.35$, $\delta = 0.85$, $\alpha = 0.4$, $\eta = 2$, and the scale parameters are $A = 2.88$, $B = 10$ and $w^m = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/1 + \eta)$. Thus, the maximum attainable migration rate is 33.3%. This calibration yields a strictly increasing equilibrium migration rate between 2.9 and 25.8% and an economic growth rate for a closed economy at the level of 4% per year if $\theta = 0.35$.

Figure 1.6: Degree of Physical Capital Altruism Effect on Equilibrium Migration Rate and Economic Growth Rate



Calibration: $\mu \in [0.01, 0.5]$, $\tau = 0.2$, $\theta = 0.35$, $\delta = 0.85$, $\alpha = 0.4$, $\eta = 2$, and the scale parameters are $A = 2.88$, $B = 10$ and $w^m = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/1 + \eta)$. Thus, the maximum attainable migration rate is 33.3%. This calibration yields a strictly decreasing equilibrium migration rate between 31.2 and 23.6% and an economic growth rate for a closed economy at the level of 4% per year if $\mu = 0.35$.

Figure 1.7: Preference for Living in the Source Country Effect on Economic Growth for Different Values of the Contribution to Human Capital Formation of Private Investment in Education (δ)



Calibration: $\eta \in [0.01, 5]$, $\theta = 0.35$, $\mu = 0.35$, $\alpha = 0.4$, $\tau = 0.2$, and the scale parameters are $A = 2.88$, $B = 10$ and $w^m = 10$. The equilibrium migration rate satisfies the condition $l_m^* \in (0, 1/(1+\eta))$. The contribution of private investment in education, δ, is equal to 0.95, 0.85 and 0.75 for the figures of panel (a), panel (b) and panel (c), respectively. This calibration yields an economic growth rate for a closed economy at the level of 4% per year if $\eta = 2$ and $\delta = 0.85$.

2 Determinants of Remittances: Theory and Evidence from Households in Ecuador

2.1 Introduction

According to World Bank data the share of remittances as a percentage of gross domestic product has grown steadily through the last three decades. By the end of the 1970s remittances for all developing countries represented only around 0.5 percent of the GDP while in 2006 it reached around 2.0 percent. Remittances have become the second-largest source of international financial resources for developing countries, after foreign direct investment, and in many cases (i.e. countries such as Guatemala, El Salvador, Nicaragua, Haiti, Dominican Republic, etc) are the largest source of external inflows. Because of these facts, there has been increased interest by scholars, policy makers and international financial agencies in analyzing the relationship between migration, remittances and economic development. Understanding the determinants of migrant remittance behavior can help to predict the future pattern of remittance flows for developing countries.

The first part of this paper develops a theoretical framework to analyze individual migrant decisions about whether to remit or not and, conditional upon remitting, the size of the remittance. This model provides answers to questions such as "Who remits?" "Why?" and "How much?". In particular, the analytical model emphasizes the relationship between individual migrant remittance behavior and the number of migrants within the same household. Using household data from Ecuador, the second part of this paper presents an

empirical analysis to assess the determinants of remittances. Although Ecuador is a small Andean country of approximately 13.9 million people, Ecuadorians are one of the largest immigrant groups in metro New York and the second largest immigrant group in Spain.[1] A massive emigration from Ecuador occurred between 1999 and 2004 as a response to the national economic crisis of 1998 and 1999, caused by the closure of the banks, devaluation (from 5,000 sucres to 25,000 sucres to the dollar), company bankruptcies and financial instability. During these two years, Ecuador's Gross Domestic Product fell by 27 percent, while per capita household consumption was lower in 1999 than 10 years earlier.[2] According to the Central Bank of Ecuador, from 1996 to 2006 remittances grew at an average rate of 19 percent annually, and since 1999 have become the second-largest source of foreign income after oil exports, exceeding official development aid and foreign direct investment. In 2006 remittances totaled 2.9 billion dollars, which represented 7.0 percent of GDP and 22.2 percent of total exports of goods and services.

According to the 2004 "Demographic, Maternal and Infant Health Survey" (ENDEMAIN), Ecuadorian migrants are spread across 30 countries, of which the most significant destination countries are Spain, the U.S. and Italy, respectively. Most of the migrants are close relatives of the household head (80 percent are parents, children or spouses). The survey includes migrants who left the country between 1960 and 2004. Most of those left between 1999 and 2004 (more than 70 percent). While the preferred countries during the last surge of migration were European such as Spain and Italy, the U.S. was a secondary destination. For instance, of the total number of Ecuadorian migrants living in Spain, around 90 percent arrived between 1999 and 2004. During the 1980's most of the Ecuadorian migrants paid intermediaries, coyotes or a document forger, for clandestine passage

[1] Jokisch (online).
[2] IDBAmérica (online).

to the United States, whereas the vast majority of the migrants during the last massive migration chose Spain. The main reason for this was an existing agreement between Spain and Ecuador that allowed Ecuadorians to enter the country as tourists without visas (the law changed in 2003). The main motivations for leaving were to search for work or to accept a job offer in the destination country.

There is a growing body of literature which focuses on the microeconomic motives behind remittances (Lucas & Stark 1985, Funkhouser 1995, Agarwal & Horowitz 2002, Amuedo-Dorantes & Pozo 2006, Osili 2007). These surveys list three basic motives for remittances: altruism, insurance (indemnifying the human and social development of the family left behind against income shocks), and investment (asset accumulation back home as part of the migration life-cycle planning).[3] This paper contributes both theoretically and empirically to this branch of the literature.

Similar to Funkhouser (1995), this study proposes a behavioral model of remittances based on altruism. It is assumed that an individual migrant takes as given the amount of remittances sent by all other migrants within the same household (Nash assumption). Existing studies have used the Nash assumption as well, but have not formally stated and tested this assumption. They predict that the individual remittance behavior is negatively associated with the number of other migrants within the same household.[4] There are several implications from the model in this paper. First of all, the relationship between individual remittance behavior and the number of other migrants within the same household is not theoretically determined. Whereas remittances decrease with the number of migrants within

[3]For a more comprehensive review of these arguments, see Lucas & Stark (1985) and the survey in Docquier & Rapoport (2006).

[4]See Funkhouser (1995) and Agarwal & Horowitz (2002). Since here it is assumed that migrants from the same household make a voluntary contribution to finance consumption in that household, non-migrant consumption might be thought of as a public good, where the possibility of migrants that free ride exists in this framework.

the same household due to the Nash assumption (more remittances sent by the others migrants, less remittances sent by one), remittances increase with the number of migrants because the household's labor income is negatively affected by the reduction of the labor supply in the source country. Whether remittances increase or decline will depend on which effect dominates. The key difference between this model and previous analytical frameworks based on altruism is that, when the migrant opportunity cost of forgone household labor income is taken into account, this model suggests that migrant remittance behavior and household migration size are non-monotonically correlated. Hence, this relationship may be empirically addressed. Next, migrants who do not remit are those with relatively low labor income, a low degree of altruism toward relatives left behind, or both.[5] On the other hand, migrants who remit are those with relatively high labor income, a high degree of altruism, or both. An associated prediction would be that migrants who migrate to higher earnings countries are more likely to remit and, when they do so, remit more than those who migrate to lower earnings countries. Finally, this model predicts that individual migrant remittances are a decreasing function of household labor income.

Another relationship to be analyzed is the migrant remittance behavior and the time since migration. The time profile of remittance behavior would depend on the earnings profiles of the migrants and the households. Whether remittances increase or decline with time after migration will depend on the relative changes over time in the migrant's wages and the household's income. A greater amount of time since the migration implies more labor market experience, which in turn implies higher wages and higher remittances. On the other hand, higher household income over time implies lower remittances. The relationship

[5]Since the migrant's degree of altruism is an unobservable parameter, it is empirically approximated by a vector of observable variables that measure the degree of proximity between migrants and relatives left behind.

between migrant worker remittances and the length of stay in the host country might be non-monotonic over time.

Using household data from Ecuador, this paper presents an empirical analysis that tests the main predictions of the theoretical model. The empirical work provides evidence that migrant remittances are a non-increasing function of the number of migrants within the household. Moreover, it shows robust evidence both for altruistically motivated remittance behavior and for the fact that the size of remittances decreases over time since the migration. Finally, the empirical section shows that Ecuadorian migrants who moved to Spain were less likely to remit and remit less than those migrants whose destination country was the United States, which might reflect the lower unemployment rate and the higher potential earnings in the United States relative to Spain.[6]

The rest of the paper is organized as follows: section 2 includes a basic theoretical framework and reduced form equation for the migrants' remittance behavior; section 3 discusses the empirical strategy and results; and the last section offers some concluding remarks.

2.2 Basic theoretical framework

2.2.1 The model

Consider a two-agent model: the migrant and the non-migrant. The individual migrant worker is represented by $i = 1, 2, ..., l^m$ from household j who lives and works in a foreign country $f = 1, 2, ..., F,$; the non-migrant refers to household $j = 1, 2, ..., S$ in the source country, which can consist of one or more individuals. There are several assumptions in this framework. First, it ignores the reasons for the migration decision, which implies that

[6] See World Bank (online).

the migrants are exogenously located in different host countries.[7] Second, each migrant is altruistic toward the non-migrant members of her own family,[8] which means that migrant i, in addition to choosing her own consumption c_i^f, has to decide how much money to transfer to her relatives in the source country (remittance size a_{ij}). Next, an individual migrant i takes the amount of remittances sent by all other migrants within the same household j as given (Nash assumption), which is denoted as a_{-ij}. Prices are the same across the host countries and the source country, and are normalized to 1.[9] Finally, all income in the source country is consumed and all migrant income net of remittances is consumed as well in the host country.

Thus, each migrant i from household j in host country f, who values both her own utility and the utility of household j in the source country, seeks to maximize a log utility

[7]Some of the leading papers dealing with migration decision theory are Sjaastad (1962), Todaro (1969) and Borjas (1987, 1989), in which the migration decision is a function of two main variables: wage differential and migration cost. Similar representations also can be found in Carrington et al. (1996), where the authors construct a discrete time model of equilibrium migration with endogenous moving costs. In this setup the cost of moving also depends on the stock of migrants already settled in the host country, which captures the "networks externality" effect.

[8]For a general discussion about the different motives for remitting covered in the literature, see Lucas & Stark (1985) and Docquier & Rapoport (2006). In addition to the altruistic behavior of migrants, these authors include other motives for remitting such as exchange, investment and inheritance-seeking. Under the exchange motive, for instance, the migrants' remittances may be viewed as repayments of loans used to finance the moving costs or the migrants' investment in human capital. Investment and inheritance-seeking motives are defined by Lucas & Stark (1985) as self-interest motives.

[9]This assumption does not change any of the substantive predictions of the model considered here. Djajic (1989) and Dustmann (1997, 1999) consider international migration models in which it is assumed that prices are higher in the host country relative to prices in the source country. This issue is not considered here, mainly to maintain simplicity and partially because it would be more relevant if we were modeling return migration as analyzed by Djajic (1989) and Dustmann (1997, 1999).

function as follows:

$$V = Max_{\{a_{ij}, c_{ij}^f\}} log(c_{ij}^f) + \theta log(c_j^h) \tag{2.1}$$

$$s.t.$$

$$c_{ij}^f + a_{ij} = w^f \tag{2.2}$$

$$c_j^h = \frac{(l_j^h w^h + a_{ij} + a_{-ij})}{n_j} \tag{2.3}$$

$$a_{ij} \geq 0, \tag{2.4}$$

for all $i = 1, ..., l^m$, $f = 1, ..., F$, and $j = 1, ..., S$, taking as given non-migrant consumption c_j^h, the amount of remittances sent by all other migrants within the same household a_{-ij}, the exogenous migrant's labor income w^f, and the exogenous household's total labor income $l_j^h w^h$, where l_j^h is the number of working members within household j in the source country, w^h denotes real wages in the source country, n_j is the number of individuals in household j (including children), and $\theta \in (0, 1)$ represents a taste parameter that characterizes heterogeneous preferences for each migrant. This taste parameter, in particular, represents the migrant's degree of altruism toward her relatives in the source country. Expressions (3.1)-(2.4) represent the migrant utility function, migrant budget constraint, non-migrant budget constraint and the non-negative of remittances condition, respectively.[10]

The utility maximization problem is:

$$Max_{\{a_{ij}\}} log(w^f - a_{ij}) + \theta log \frac{(l_j^h w^h + a_{ij} + a_{-ij})}{n_j}$$

$$s.t.$$

$$a_{ij} \geq 0.$$

This maximization problem yields a continuous function called the i^{th} migrant best

[10]This approach looks similar to that discussed in the literature of private provision of public goods. See Bergstrom et al. (1986), Andreoni (1988, 1990) and Kotchen & Moore (2007).

response function:

$$a_{ij} = max\{\frac{(\theta w^f - l_j^h w^h - a_{-ij})}{(1+\theta)}, 0\}. \tag{2.5}$$

As expected, the individual migrant i's best response function for remittances is a decreasing function of the amount of remittances sent home by all other migrants within the same household, a_{-ij}. Now, let l_j^m denote the number of migrants within household j such that the total household labor supply is $l_j = l_j^m + l_j^h$. Then, under the assumption of a symmetric equilibrium, let $a_j = l_j^m a_{ij}$ denote the total amount received by household j in equilibrium. As follows from (2.5), the individual migrant's optimal amount of remittances sent to her relatives left behind is

$$a_{ij} = max\{\frac{\theta w^f - (l_j - l_j^m)w^h}{(l_j^m + \theta)}, 0\} \equiv a(\theta, w^f, l^m, l). \tag{2.6}$$

From (2.6), remittances are an increasing function of the migrant's labor income, w^f, and of the migrant's degree of altruism toward non-migrants, θ, and a decreasing function of the household labor income, w^h. The relationship between the migrant worker remittances and the number of migrants within the same household, however, is ambiguously determined. When household migration increases exogenously, the amount of remittances sent by all other migrants within the household increases, while migrant i's best response function would predict that migrant i's remittances would decline. The latter prediction might be counter-balanced, however, by a decrease in the household labor income due to the lower household labor supply in the source country (i.e. forgone migrant wages in the source country), which would imply that remittances increase when household migration increases.[11] As follows from (2.6), the derivative of remittances with respect to migration

[11] Here, the exogenous change of household migration might be a strong assumption, but it can be thought of as a remarkable change in the immigration policies of a host country that would allow migrant workers with particular qualifications or from a specific source country to move to that host country without any significant moving cost. For example, Mexican workers who live next to the Mexican-U.S. border might easily migrate to the U.S. if border enforcement policy in the U.S. was markedly changed.

size is given by

$$\frac{\partial a}{\partial l^m} = \frac{w^h - \theta(w^f - w^h)}{(l^m + \theta)^2}. \tag{2.7}$$

Since wage differential is positive, $\theta > \frac{w^h}{(w^f - w^h)}$, which implies that migrant remittances are negatively associated with migration size. When $\theta < \frac{w^h}{(w^f - w^h)}$, migrant remittances are positively associated with the number of migrants within the household. Hence, the relationship between remittance behavior and migration size depends on the wage gap and the unobservable migrant's degree of altruism. If the migrant's degree of altruism is sufficiently large (small) and there is a large (small) wage gap between host country f and the migrant source country, it is more likely that remittance behavior and migration size are negatively (positively) correlated. Since the relationship between migration size and individual migrant remittance behavior is not determined, the empirical work of this paper examines this relationship.

To close the model, let $w^{f^*}(\theta)$ be a critical level of migrant labor income such that the migrant equilibrium remittances for each individual i from household j is given by

$$a^*_{ij} = \begin{cases} \frac{(\theta w^f - (l_j - l^m_j)w^h)}{(l^m_j + \theta)} & if\ w^f > w^{f^*} = \frac{(l_j - l^m_j)w^h}{\theta} \\ 0 & Otherwise, \end{cases} \tag{2.8}$$

where the inequality condition on the right side of (2.8) states that if the actual migrant labor income is greater than her critical level $\frac{(l_j - l^m_j)w^h}{\theta}$, then migrant i sends a positive amount of remittances to her relatives in the source country. There are several implications from (2.8). First, individual remittance behavior is ambiguously associated with the number of other migrants within the same household, which is a direct consequence of the Nash assumption and the altruistically motivated migrant remittance behavior (see equation 2.7). Hence, this relationship may be empirically addressed. Second, migrants with different tastes have different critical levels of income. Conditional on the household labor income and the

number of migrants within the same household, the decision to remit or not to remit (free rider) depends on whether the actual migrant labor income is greater than (does remit) or less than (does not remit) her critical level of labor income. Migrants who do not remit are those with relatively low labor income, a low degree of altruism toward their relatives left behind, or both. On the other hand, migrants who remit are those with relatively high labor income, a high degree of altruism, or both. Third, since individual migrants stay in different host countries, migrants who migrate to higher earnings countries are more likely to remit and, they remit more than those who migrate to lower earnings countries. Finally, this model predicts that individual migrant remittances are a decreasing function of household labor income.

2.2.2 Time profile of remittances

Moving beyond the predictions of the one period model described above, this section discusses the time profile of migrant remittance behavior. A survey conducted by Multilateral Investment Fund and Pew Hispanic Center in 2003 found that 42 percent of migrant workers from Latin American countries (about six million people) send remittances home on a regular basis. However, the observed probability of remitting is not constant across that population but is instead higher among more recently arrived migrant workers. While half of all Latin American migrant workers who have been in the United States for 10 years or less are regular remittance senders, the observed probability for those who have been there between 10 and 20 years is about 40 percent and for those between 20 and 30 years it is about 20 percent, suggesting that the likelihood of remitting declines over time. However, from a theoretical view the relationship between remittance behavior and the duration of

the migration is ambiguously determined.[12]

In order to address the time profile of remittances, we construct a multi-period model, similar to that described above, in which all income is spent in each period by both the migrants and the non-migrants (i.e. there is no saving and no intertemporal discount factor). The optimal solution for remittances is similar to that shown by expression (2.8), except that it would have a script t denoting time, $a^*_{ij,t}$.[13] Without any loss of generality for simplicity, we can assume that migrant labor income and household labor income can vary over time while household migration is maintained constant over time. Migrant labor income can increase over time with labor market experience in the host country while household labor income can increase over time as household members improve their educational attainment over time, gain labor market experience or increase household labor supply over time (children become adults). Moreover, we assume that no moral hazard is involved in the sense of household members reducing effort over time. Then, the time profile of remittance behavior would depend on the earnings profiles of the migrants and the households. Whether remittances increase or decline over time will depend on the relative changes in the time profile of the migrant's wages and the household's income. A greater number of years since the migration implies more labor market experience, which in turn implies higher wages and higher remittances. On the other hand, higher household income over time implies lower remittances. Thus, the relationship between migrant worker remittances and the length of stay in the host country might be non-monotonic over time.

[12] Funkhouser (1995) examines this relationship in a multi-period model. He shows that migrant remittance behavior and time since migration are ambiguously determined.

[13] That is,

$$a^*_{ij,t} = \begin{cases} \frac{(\theta w^f_t - (l_{j,t} - l^m_j) w^h_t)}{(l^m_j + \theta)} & if\ w^f_t > w^{f^*}_t = \frac{(l_{j,t} - l^m_j) w^h_t}{\theta} \\ 0 & Otherwise. \end{cases}$$

2.3 Empirical Analysis

2.3.1 Reduced form of remittances equation

The reduced form expression for the binary choice variable determining the fraction of migrants who do remit and the size of remittances is given by:

$$a_{ij}^{*} = max\{a^{*}([W_i, R_{ij}, Z_j, l_j^m] \equiv X), 0\}, \tag{2.9}$$

for $i = 1, ..., M$ and $j = 1, ..., S$. The set of observable variables included in (2.9) is used to approximate equation (2.8) as follows. First, W_i denotes a vector that includes all characteristics of the individual migrant i that determine migrant wages in the host country, including years of experience in the host country, destination country (wages vary across developed countries), motivation for leaving the source country and the migrant's education level prior to migration. Next, R_{ij} is a vector that represents migrant i's status within household j (i.e. the migrant is the household head's spouse, parent, child, etc.) and is used to approximate migrant i's degree of altruism toward household j.[14] Z_j is a vector that includes all characteristics of household j that determine its labor income (education level of household's head, ratio of children to adults within the household and gender of household's head). Finally, l_j^m represents the number of migrants within household j.

According to the discussion above, there are five testable hypotheses associated with the migrant's decision to remit and the amount to be transferred to her relatives in the source country. First, migrants with higher labor income are more likely to remit and tend to remit more. Second, households with lower income tend to receive more remittances. Third, both the likelihood of remitting and remittance size are positively related to the degree of proximity between the migrants and the remaining household members in the source

[14] Usually the unobservable migrant's degree of altruism is approximated by a vector of observable variables that measure the degree of proximity between individual migrants and their families in the source country, which is the case in Lucas & Stark (1985), Funkhouser (1995) and Osili (2007), among others.

country. Fourth, the relationship between migrant worker remittances and the length of stay in the host country might be non-monotonic over time. Fifth, remittances per migrant are ambiguously associated with the number of migrants within the same household.

2.3.2 Data

The data used in this paper come from a national household survey entitled "Demographic, Maternal and Infant Health Survey" (ENDEMAIN) undertaken by the Center of Population Studies and Social Development in Ecuador in 2004. The empirical work focuses on households with at least one migrant, which comprise around 10 percent of the households sample covered in the Ecuadorian household survey. The sample includes migrants age 15 or older. The Ecuadorian households in this survey have from one to five migrants. The survey provides information about each of the household members in Ecuador and about each of the migrants within the household. The migrants' data includes information about the length of migration, the host country, the status within the household, the motivation for migration, the years of schooling prior migration and the individual amount of remittances sent by each of them. Table 2.1 presents the migrant remittance behavior by the number of migrants within the households, with the remittances expressed in U.S. dollars. The first column shows the full sample migrant remittance behavior, whereas columns (1) to (5) show the statistics for individuals who come from households with 1, 2, 3 4, and 5 migrants, in that order. Panel (A) of table 2.1 shows the amount of remittances, including those who remit (remitter) and those who do not remit (non-remitter), to have averaged 1,164 and 353 dollars sent per migrant and received per household member, respectively.[15] Panel (B) shows the amount of remittances of only those who remit to have averaged 1,870

[15]Remittances received per household member were computed as the the ratio of the individual migrant amount of remittance to household size in Ecuador.

and 567 dollars sent per migrant and received per household member, correspondingly. The percent of migrants who remit by number of migrants within the household range from 55 to 66 percent, with the average being 62 percent.

Table 2.2 shows the descriptive statistics of migrant characteristics and household characteristics. Ecuadorian migrants are spread across 30 countries, of which the most significant destination countries are Spain, the U.S. and Italy, respectively. Most of the migrants are close relatives of the household head (80 percent are parents, children or spouses). The survey includes migrants who left the country between 1960 and 2004. Most of those left between 1999 and 2004 (more than 70 percent), which might be associated with the volatile macroeconomic situation of the late 1990's and the early 2000's. While the preferred countries during the last surge of migration were European such as Spain and Italy, the U.S. was a secondary destination. For instance, of the total number of Ecuadorian migrants living in Spain, around 90 percent arrived between 1999 and 2004. The main motivations for leaving were to search for work or to accept a job offer in the destination country. Since there are some differences of remittance behavior of Ecuadorian migrants according to the host country, the number of migrants within the same household and the years since migration, in the empirical work we take into account those factors that affect the likelihood of remitting and the size of remittances.

2.3.3 Empirical methodology

Using household data from Ecuador, this study attempts to answer questions such as Who remits? Why? and How much?. In particular, the empirical work emphasizes the relationship between individual migrant remittance behavior and the number of migrants within the same household. This section explores two different ways to introduce household migration

into the econometric model. First, similarly to Funkhouser (1995) and Agarwal & Horowitz (2002), household migration enters linearly into the regression model by using the number of migrants within the household. Second, in order to explore the potentially non-linear relationship between remittances and household migration, it uses indicators for the number of migrants within the household (i.e. 1 if household has 1 migrant, 1 if household has 2 migrants, etc.). The non-linear approach allows one to investigate whether remittance behavior changes between migrants who come from households with 1 migrant and those from households with 2, between migrants who come from households with 2 migrants and those from households with 3, and so on. Both sets of regressions are reported in the empirical results section.

Since migrant remittance behavior implies a two-step decision (see equation (2.8)), the decision to remit or not and, conditional upon remitting, the amount decision, let's consider a censoring from below (zero) or from the left mechanism in which is observed

$$a = \begin{cases} a^* & if \quad a^* > 0 \\ 0 & if \quad a^* \leq 0. \end{cases} \tag{2.10}$$

Censoring can be fully parametrically specified. We consider maximum likelihood estimation (MLE) given censoring from zero.[16] For $a > 0$ the density of a is the same as that for a^*, so $f(a \mid x) = f^*(y \mid x)$, where x represents the set of exogenous variables defined in expression (2.10). For $a = 0$, the density is equal to the probability of observing $a^* \leq 0$, or equal to $F^*(0 \mid x)$. Hence, the censoring mechanism can be written

$$f(a \mid x) = \begin{cases} f^*(a \mid x) & if \quad a > 0 \\ F^*(0 \mid x) & if \quad a = 0. \end{cases} \tag{2.11}$$

[16] According to the theoretical model, the altruistically motivated remittances are allowed only in one direction, namely from migrants to non-migrants, but not from non-migrants to migrants.

Now, let an indicator variable be introduced

$$d = \begin{cases} 1 \quad if \quad a > 0 \\ \\ 0 \quad if \quad a = 0, \end{cases} \tag{2.12}$$

and therefore the conditional density given censoring from zero is given by

$$f(a \mid x) = [f^*(a \mid x)]^d [F^*(0 \mid x)]^{(1-d)}. \tag{2.13}$$

For a sample of N independent observations, the censored MLE for the migrant remittance behavior maximizes

$$lnL_N(\beta) \sum_{i=1}^{N} = d_i lnf^*(a_i \mid x_i, \beta) + (1 - d_i) lnF^*(0 \mid x_i, \beta), \tag{2.14}$$

where β are the parameters of the distribution of a^*. The censored MLE is consistent and asymptotically normal, provided that the density of the uncensored variable is correctly specified $f^*(a_i \mid x_i, \beta)$.[17] A few econometric issues arise in the estimation of expression (2.14), however. First, since there is a considerable number of zeros on the left side of (2.14), 38 percent of migrants do not remit, one has to take into account the zero-inflated issue. Second, since the Tobit estimation makes a strong assumption that the same probability mechanism generates both the zeros and the positive value of remittances, the Tobit estimates are biased if there is heteroscedasticity in the residuals of the participation regression and/or outcome regression. To account for these econometric issues, the zero-inflated nature of the dependent variable and the biased estimates from the standard Tobit model, a censored or two-part model is used, which is more flexible to allow for the possibility that the zero and positive values are generated by different mechanisms.[18] Hence, the two-part estimation employs a logit regression for the censoring mechanism (decision to remit or

[17] For a further discussion see Cameron & Trivedi (2005, 2009).

[18] The distribution that applies to a_i is a mixture of discrete and continuous distributions. Under such circumstances, there are a variety of models that could be estimated to account for the combined nature of the distribution of a_i. See Amuedo-Dorantes & Pozo (2006) for a discussion on those alternative models.

not) and, conditional on the outcome (amount decision) being observed, it uses a log-normal model for remittance size.[19] The two parts are assumed to be independent and estimated separately as shown in the next section.[20] Moreover, since correlation among error terms of all migrants experiencing the same shocks within a given host country may bias the sample errors downward, all standard errors (ε_{ijf}) are clustered by the migrant's host country.

The econometric work estimates the following model to examine the determinants of remittance behavior:

$$a_{ijf} = \begin{cases} \alpha + \beta l_j^m + \delta R_{ij} + W_i\gamma + Z_j\eta + \varepsilon_{ijf} \\ max\{a_{ijf}^*, 0\}, \end{cases} \tag{2.15}$$

where a_{ijf} is a binary variable which takes the value of one or zero for the migrant decision to remit or not to remit and, conditional on the sending of remittances, it measures the annual amount of remittances sent by individual migrant i to household j from host country f, l_j^m is the migration size or the indicator of the number of migrants from household j, R_{ij} is a dummy indicating migrant i's relationship with the household head in the source country, W_i is a vector of dummy variables that includes all characteristics of migrant i including her host country, length of stay, education level prior to migration and motives for leaving the source country, and Z_j denotes a vector of household characteristics, which includes the gender of the household's head and the ratio of children to adults within the household.

[19] Here, to ensure a positive value for the dependent variable, the density should be that for a positive-valued random variable, such as the log-normal, or an appropriate density such as the normal truncated distribution from below at zero. Also, in a random utility model (RUM), which is compatible with the theoretical model discussed in this paper, assuming that the random component of both utilities are extreme value type I distributed, it can be shown that the resultant distribution is a logistic distribution for the censoring mechanism. Hence, the logistic distribution assumption for the censoring mechanism is a proper assumption here, but also one can assume a probit model and the estimates would be unchanged.

[20] Allowing for the errors to be correlated as assumed in the sample selection model (MLE and the two-step Heckman sample selection model) does not affect the main findings of the empirical work shown in the next section. This is because both the inverse Mill's ratio and the correlation between errors of the decision to remit or not and the amount decision regression (ρ) are statistically insignificant (results can be provided upon request to the author).

2.3.4 Results

The main results of the estimates of the determinants of remittances in Ecuador are shown in tables 2.3-2.6, in which we report the estimates of the two-part model of equation (2.15). The dependent variable for the logit regression model is equal to 1 if the migrant remits and equal to 0 if the migrant does not remit. For the OLS regression model, the dependent variable in tables 2.3 and 2.4 is the log of the annual amount of remittances, in U.S. dollars, sent per each migrant, whereas in tables 2.5 and 2.6 the dependent variable is the annual amount of remittances, in U.S. dollars, received per household member in Ecuador. Columns (1) and (2) show the average marginal probability computed from the logit regression model for the decision to remit or not to remit and columns (3) and (4) report the estimates of OLS regression to examine the determinants of the amount of remittances.[21] The only difference between columns (1) and (2) and between columns (3) and (4) of those tables is that columns (1) and (3) report the standard-robust errors and columns (2) and (4) report the cluster-robust standard errors at the migrant host country level. Tables 2.3 and 2.5 provide the estimation results for the model with linear household migration (size of migration), whereas table 2.4 and 2.6 give the results for the model with non-linear household migration (dummies for the number of migrants within the household).

The estimates shown by table 2.3 are qualitatively similar to those findings reported by table 2.5, while the estimates of table 2.4 are also similar to those results shown by table 2.6.[22] Therefore, the estimates shown in this paper seem to be robust to an alternative

[21] Notice that the estimates reported in columns (1) and (2) of tables 2.3 and 2.5 are the same because the dependent variable for the logit regressions is the same in both tables, namely equal to 1 if the migrant remits and equal to 0 if the migrant does not remit. For the same reason, the estimates in columns (1) and (2) of tables 2.4 and 2.6 are the same.

[22] Notice that the same regressors that are statistically significant in table 2.3 are significant in table 2.5 as well. In general, the same applies for the estimates reported by tables 2.4 and 2.6, except for the coefficients of the regressors of both "migrant's host country is Italy" and "migrant's status within the family is not a close relative". The migrant's host country coefficient is statistically significant in table 2.4, but it is not in table 2.6 and the migrant's status within the household is not statistically significant in table 2.4, but it is

measure of remittance size.

The results for Ecuadorian migrants are generally supportive of the predictions of the model. Tables 2.3 and 2.5 show that there is a negative relationship between migrant remittance behavior and the migration size within the same household. Both the decision to remit and the size of remittance are negatively associated with migration size and are statistically significant.[23] If the migration size increases by 1 migrant, the likelihood of sending or receiving remittances decline, on average, 2 percent and the amount sent per migrant and received per household member decline, on average, 13.7 and 18.5 percent, respectively. Even though this result may be consistent with the prediction of the theoretical model, it might require a deeper inspection.[24] It could be induced by the large difference between the amount sent by individual migrants who come from households with one migrant and the amount sent by those who come from households with more than one migrant. In fact, the average amount of remittances sent by those individuals who are the sole migrants within their households is almost twice as large as that sent by those who come from households with 2, 3 and 4 migrants (see table 2.1).

In order to show a more complete picture of the relationship between migrant remittance behavior and household migration, tables 2.4 and 2.6 show the estimates of indicators for those coming from households with 2, 3, 4, or 5 migrants, where the omitted group is migrants who are the sole migrants within their households. As expected, the amount of remittance sent by individual migrants who come from households with 2 to 5 migrants

in table 2.6.

[23]Henceforth the magnitude results shown here are taken from tables 2.4 and 2.6. The estimates of the logit regressions are the same in both tables, but the estimates of the OLS regression are different, namely, the estimates of table 2.4 refer to amount sent per migrant and the estimates of table 2.6 refer to the amount received per household member in Ecuador.

[24]The theoretical model described above predicts that more migrants implies lower remittances by the Nash assumption. If this effect overcomes the implied reduction of household income due to the forgone earnings, then migrant remittance behavior and migration size would be negatively associated.

is significantly lower than that sent by individuals who are the sole migrants within their household. As follows from table 2.4, the migrants who come from households with 2, 3, 4 and 5 migrants remit 32.1, 35.2, 23.9 and 34.4 percent less, respectively, than the migrants who come from households with one migrant. Similarly from table 2.6, the amount received per household member with 2, 3, 4, and 5 migrants is 43.6, 46.1, 36.7 and 89.4 percent lower, in that order, than the amount received by those individuals from households with only one migrant, in that order. However, only those individuals who come from households with 4 migrants have a statistically significant lower likelihood of remitting than those from households with only 1 migrant (-13.7 percent). A closer inspection of the estimates of the remittance size regression reveals that coefficients for migrants who come from households with 2, 3 and 4 migrants are not statistically different.[25] However, migrants who come from households with 5 migrants tend to remit a significantly lower amount of remittances than those migrants who come from households with 2, 3 or 4 migrants.

These findings suggest that remittance size and household migration are no increasing associated. Hence, it seems that when migration size changes from 2 to 3 and from 3 to 4 migrants within the same household, the forgone household income due to migration might have a positive effect on altruistically motivated remittances, which compensates for the negative effect of the increased number of migrants on the individual amount of remittances. If there is a positive selection of migrants in the sense that the more educated individuals within the household are those who migrate, then one would expect that the forgone household income due to migration is higher than when there is a negative selection. According to the Ecuadorian data of households with at least 1 migrant, prior to migration the individuals who left had a higher education level than those relatives left behind. The

[25] One cannot reject the null hypothesis that coefficients are equal.

average years of schooling of the migrants was 3.5 years higher than the non-migrants. Moreover, the higher the migration rate within a household, the more the labor supply of that household is reduced.[26] The results of allowing a non-linear relationship between migrant remittance behavior and household migration are partially distinguished from those reached when there is a linear relationship (tables 2.3 and 2.5) and also contrast with the predictions of rent-seeking literature.[27] Summarizing, the empirical evidence discussed above suggests that migrant worker remittance behavior is a non-increasing function of the number of migrants within the household.

This paper also finds robust evidence in favor of altruistically motivated remittance behavior. There are several signs that remittances might be altruistically motivated. First, households headed by females are more likely both to receive and to receive more remittances than households whose heads are males. If the households' heads are females, they are on average, 11.4 percent more likely to receive remittances than households headed by males and when the former do receive remittances, the amount sent per migrant and received per household member is 34.4 and 66.9 percent higher, respectively, than the amount sent to and received by the latter households. The facts that the female labor participation rate is likely lower than the male labor participation rate in developing countries and that female wages are likely lower than those earned by their male counterparts support the altruistically motivated remittance hypothesis. Second, households with higher ratios of children to adults are more likely to receive remittances and in greater amounts. When the percentage of children within the households increases 1 percent, the probability of

[26] Here, migration rate is defined as the ratio of the number of migrants within the household to the total number of individuals age 15 or older within the household (including migrants).

[27] As pointed out by Docquier & Rapoport (2006), if we allow for multiple migrants competing for inheritance, then "we would expect remittances per migrant to first increase and then decrease with the number of other migrants as the effect of competition is offset by the decrease in one's probability of inheritance".

sending or receiving remittances increases 0.2 percent and the amount sent per migrant and received per household member increases 1.2 and 0.8 percent, respectively. A higher child ratio means lower labor income per individual within the household and this result implies that such households are more likely to receive remittances and to receive more than households with a lower ratio of children to adults. According to the Ecuadorian data, of the sample of households with at least one migrant, less than 7 percent of the children were involved in household labor activities or in remunerated labor.

The migrant's status within the household is also relevant in determining remittance behavior. Migrants who are not spouses, parents or children of the remaining household head are less likely to send money and send less than those who are. When the migrant is not a close relative of the household's head, the likelihood of sending remittances is 24.6 percent lower than when migrants are close relative. The amount received per household member from migrants who are not close relatives is 25.6 percent lower than the amount received from migrants who are close relatives. Migrants whose motivation for migration was studying or unifying the family are less likely to remit (-15.2 percent) and remit less than migrants whose motivation for migration was the search for work or accepting a labor offer in the host country. The elasticity of the amount sent per migrant and received per household member with respect to the migrant's left for studying or unifying family is equal to 44.0 and 41.9 percent, respectively. Finally, the migrant's years of schooling are not significantly correlated with the probability to remit, but of those migrants who remit, the more educated persons tend to send a higher amount of remittances.[28] The elasticity of the amount sent per migrant and received per household member with respect to the

[28]This finding is similar to that found by Osili (2007), where remittances are more likely motivated by investment motives or saving motives in the source country. It is also consistent with the predictions of repayment-motivated remittances.

migrant's years of schooling is equal to 3.4 and 4.4 percent, respectively.

Also of note, while the relationship between the likelihood of remitting and the length of time since migration seems to show a kind of U-inverse-shaped curve (increasing at the beginning of the stay in the host country and declining later), the relationship between the amount of remittances and the length of stay appears to show a U-shaped curve.[29] The migrant's host country also seems to be important in explaining migrant worker remittance behavior. Ecuadorian migrants who moved to Spain are 1.7 percent less likely to remit and remit 22.7 percent less than those migrants whose destination country was the United States, which might reflect the lower unemployment rate and the higher potential earnings in the United States relative to Spain. According to World Bank data, while the per capita income in the U.S. was 36,451 dollars in 2004 (constant 2000 U.S. dollars), the per capita incomes in Spain was 15,356 dollars in 2004. Likewise, the unemployment rates in the U.S. and Spain in 2004 were 6 percent and 11 percent, respectively. The fact that European countries such as Spain and Italy were choices for Ecuadorian migrants, despite the lower potential earnings there relative to the U.S., could reveal the depth of the decline of per capita income in Ecuador during the last migration surge (1999 to 2004). Thus, it might suggest that the extent of the income differential became sufficiently high that migration to Spain and Italy was then profitable, which perhaps would not happen given a predominance of long term economic conditions. As a matter of fact, before 1999 the preferred destination

[29] Additional estimations using dummies instead of years of stay show that migrants who left the source country within 5 years tend to remit more than those migrants who stayed in the host country for more than 5 years. However, the probability to remit is not significantly affected by the migrant's years of stay in the host country. Lucas & Stark (1985) link duration of migration with remittances as follows: "If out of sight, out of mind were the rule, one should expect remittances to fade with duration of absence. If repayment of school costs were the target, again remittances should ultimately cease", whereas **?** investigate repayments of international migration costs instead of education costs in Pakistan. Therefore, another competing hypothesis that may justify the remittance behavior reported here would be "repayment motives", which may include repayments of incurred moving costs or repayments of education costs. A further discussion can be seen in Docquier & Rapoport (2006), in which the authors contrast predictions of competing hypotheses.

country for Ecuadorian migrants was the U.S..

2.4 Conclusions and final comments

The analytical model developed in this paper analyzes the determinants of individual migrant remittance behavior and extends the altruism-based frameworks proposed by Lucas & Stark (1985) and Funkhouser (1995). This model predicts that migrants with higher labor income are more likely to remit and tend to remit more, households with lower income tend to receive more remittances, both the likelihood of remitting and remittance size are positively related to the degree of proximity between the migrants and the remaining household members in the source country and the relationship between migrant worker remittances and the length of stay in the host country might be non-monotonic over time. It also demonstrates that when forgone household labor income is taken into account the individual migrant remittance is a non-increasing function of household migration size. The main findings in the empirical part of this paper are generally supportive of the predictions of the model.

Future research related with remittances might be focused on the consequences of remittances for developing countries. Remittances may prove poverty-alleviating and reduce inequality, either directly through flows to the poor, if not the poorest, or indirectly through a stimulant effect on the local economy. Moreover, remittances may have long-term effects by overcoming liquidity constraints and allowing investment in the education and health care of receiving families. Similarly, remittances create a stable source of income which has a positive effect on exchange reserves and the balance of payments and might enhance financial development in small cities or towns of the source country. As foreign exchange inflow, remittances enter the economy in a different way than private capital inflows, for-

eign investment or financial aid, and, until now, there is no systematic study for a better understanding of those differences. In fact, macroeconomic effects remain poorly modeled and poorly understood. Particularly lacking are models that may facilitate the evaluation of both migration and remittance effects. However, many nations, like Ecuador, presume major benefits from remittance inflow and some actively promote additional flow, both through efforts to lower transfer fees and through offers of alternatives for investment with government and international agency support.

Table 2.1: Ecuadorian Migrant Remittance Behavior by Number of Migrants within the Household

Variables	**Full Sample**	**Number of Migrants within the Household**				
		One	**Two**	**Three**	**Four**	**Five**
A. Remitter and Non-Remitter						
Remittances Per Migrant	1,164	1,539	879	843	808	749
Remittances Per Household Member	353	490	257	261	201	146
Number of Observations	1529	705	389	202	149	84
B. Only Remitter						
Remittances Per Migrant	1,870	2,369	1,500	1,281	1,469	1,234
Remittances Per Household Member	567	754	438	397	365	241
Number of Observations	952	458	228	133	82	51
C. Percentage of Migrants Who Remit	0.62	0.65	0.59	0.66	0.55	0.61

Data Source: 2004 Demographic, Maternal, and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. Remittances are expressed in U.S. dollars

Table 2.2: Ecuador: Migrant and Non-migrant Characteristics

Variables	**Full Sample**	**Number of Migrants within the Household**				
		One	**Two**	**Three**	**Four**	**Five**
A. Household Characteristics						
Size of Migration	2.030	1	2	3	4	5
Migration Rate	0.337	0.235	0.360	0.452	0.470	0.584
1 if Household's Head is Female	0.332	0.381	0.254	0.356	0.281	0.309
Years of Schooling	6.5	7.4	6.2	5.9	5.2	5.0
Percentage of Children within the Household	19.25	21.92	17.05	15.1	21.1	13.4
B. Migrant Characteristics						
B1. Length of Migration						
1 if from 0 to 1 year	0.147	0.173	0.118	0.173	0.114	0.071
1 if from 2 to 5 years	0.599	0.639	0.614	0.475	0.510	0.654
Years since Migration	4.9	4.4	5.3	5.3	5.8	5
B2. Host Country						
1 if Host Country is Spain	0.454	0.496	0.437	0.381	0.463	0.345
1 if Host Country is Italy	0.057	0.069	0.061	0.039	0.040	0.011
1 if Host Country is Other (27 others)	0.068	0.093	0.061	0.034	0.053	0
B3. Status within the Household						
1 if Migrant is not a Close Relative	0.207	0.194	0.205	0.287	0.154	0.226
B4. Motive for Migration						
1 if Left for Studying or Unifying Family	0.170	0.180	0.179	0.138	0.100	0.238
B5. Education						
Years of Schooling	9.8	10.1	9.8	8.9	10.0	9.3

Data Source: 2004 Demographic, Maternal, and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. Total annual and average annual remittances are expressed in U.S. dollars. Household size was computed by adding up the number of migrants within the household and the number of individuals age 15 or older within the household who stay in Ecuador.

Table 2.3: Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances in U.S. Dollars for the OLS Model

Variable	**Two Part Model**			
	Logit Model (AME)		**OLS Model**	
	(1)	**(2)**	**(3)**	**(4)**
A. Household Characteristics				
Size of Migration	-0.020**	-0.020***	-0.137***	-0.137***
	(0.0098)	(0.0076)	(0.0374)	(0.0409)
1 if Household Head is Female	0.119***	0.119***	0.347***	0.347***
	(0.0248)	(0.0156)	(0.0923)	(0.1179)
Ratio of Children to Adults	0.0022***	0.002***	0.012***	0.012***
	(0.0006)	(0.0006)	(0.0026)	(0.0012)
B. Migrant Characteristics				
Length since Migration	0.017**	0.017***	-0.062***	-0.062***
	(0.0088)	(0.0051)	(0.0228)	(0.0206)
Length since Migration Squared	-0.001*	-0.001***	0.002**	0.002***
	(0.0004)	(0.0001)	(0.0008)	(0.0004)
Host Country is Spain	-0.023	-0.023***	-0.201*	-0.201***
	(0.0269)	(0.0075)	(0.1031)	(0.0328)
Host Country is Italy	-0.009	-0.009	-0.152	-0.152**
	(0.0527)	(0.0102)	(0.1920)	(0.0560)
Host Country is Other (27 others)	-0.208***	-0.208***	-0.151	-0.151
	(0.0512)	(0.0730)	(0.2471)	(0.2107)
Migrant is not a Close Relative	-0.238***	-0.238***	-0.224*	-0.224*
	(0.0301)	(0.0444)	(0.1295)	(0.1169)
Left for Studying or Unifying Family	-0.149***	-0.1493***	-0.459***	-0.459*
	(0.0336)	(0.0551)	(0.1423)	(0.2392)
Years of Schooling	-0.004	-0.0042	0.035***	0.035**
	(0.0029)	(0.0032)	(0.0115)	(0.0123)
Constant	0.756***	0.756**	6.644***	6.644***
	(0.2537)	(0.3140)	(0.1986)	(0.0656)
Observations	1529	1529	952	952
Pseudo R^2	0.0868	0.0868		
R-Squared			0.1144	0.1144

Data Source: 2004 Demographic, Maternal and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. While columns (1) and (3) report robust standard errors, columns (2) and (4) report cluster-robust standard errors at the migrant host country level. Coefficients of the logit model are the average marginal effect (AME), which are computed using the added command $margeff$. * significant at 10%, ** significant at 5%, and *** significant at 1%.

Table 2.4: Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances in U.S. Dollars for the OLS Model

Variable	**Two Part Model**			
	Logit Model (AME)		**OLS Model**	
	(1)	**(2)**	**(3)**	**(4)**
A. Household Characteristic				
Household has 2 Migrants	-0.051*	-0.051	-0.321***	-0.321***
	(0.0298)	(0.0451)	(0.1106)	(0.0548)
Household has 3 Migrants	0.016	0.016	-0.352**	-0.352***
	(0.0390)	(0.0612)	(0.1461)	(0.1033)
Household has 4 Migrants	-0.137***	-0.137***	-0.239	-0.239**
	(0.0428)	(0.0441)	(0.1480)	(0.1131)
Household has 5 Migrants	-0.037	-0.037	-0.686***	-0.686*
	(0.0535)	(0.0446)	(0.1986)	(0.3503)
1 if Household Head is Female	0.114***	0.114***	0.344***	0.344***
	(0.0250)	(0.0136)	(0.0924)	(0.1123)
Ratio of Children to Adults	0.002***	0.002***	0.012***	0.012***
	(0.0006)	(0.0007)	(0.0026)	(0.0014)
B. Migrant Characteristics				
Length since Migration	0.0191**	0.019***	-0.066***	-0.066***
	(0.0089)	(0.0047)	(0.0229)	(0.0195)
Length since Migration Squared	-0.001*	-0.001***	0.002**	0.002***
	(0.0004)	(0.0001)	(0.0008)	(0.0004)
Host Country is Spain	-0.017	-0.017**	-0.227**	-0.227***
	(0.0268)	(0.0078)	(0.1043)	(0.0383)
Host Country is Italy	-0.004	-0.0042	-0.161	-0.161**
	(0.0521)	(0.0128)	(0.1928)	(0.0588)
Host Country is Other (27 others)	-0.200***	-0.200***	-0.178	-0.178
	(0.0521)	(0.0748)	(0.2514)	(0.2138)
Migrant is not a Close Relative	-0.246***	-0.246***	-0.209	-0.209
	(0.0300)	(0.0408)	(0.1317)	(0.1302)
Left for Studying or Unifying Family	-0.152***	-0.152***	-0.440***	-0.440*
	(0.0335)	(0.0484)	(0.1419)	(0.2132)
Years of Schooling	-0.003	-0.003	0.034***	0.034**
	(0.0028)	(0.0037)	(0.0116)	(0.0143)
Constant	0.614**	0.614*	6.588***	6.588***
	(0.2403)	(0.3649)	(0.1935)	(0.1514)
Observations	1529	1529	952	952
R-squared			0.1194	0.1194
Pseudo R^2	0.0914	0.0914		

Data Source: 2004 Demographic, Maternal and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. While columns (1) and (3) report robust standard errors, columns (2) and (4) report cluster-robust standard errors at the migrant host country level. Coefficients of the logit model are the average marginal effect (AME), which are computed using the added command $margeff$. * significant at 10%, ** significant at 5%, and *** significant at 1%.

Table 2.5: Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances per Household Member (Receivers) in U.S. Dollars for the OLS Model

Variable	**Two Part Model**			
	Logit Model (AME)		**OLS Model**	
	(1)	**(2)**	**(3)**	**(4)**
A. Household Characteristics				
Size of Migration	-0.020**	-0.020***	-0.185***	-0.185***
	(0.0098)	(0.0076)	(0.0370)	(0.0307)
1 if Household Head is Female	0.119***	0.119***	0.675***	0.675***
	(0.0248)	(0.0156)	(0.0923)	(0.1421)
Ration of Children to Adults	0.002***	0.002***	-0.007***	-0.007***
	(0.0006)	(0.0006)	(0.0026)	(0.0015)
B. Migrant Characteristics				
Length since Migration	0.017**	0.017***	-0.057**	-0.057**
	(0.0088)	(0.0051)	(0.0224)	(0.0247)
Length since Migration Squared	-0.001*	-0.001***	0.002***	0.002***
	(0.0004)	(0.0001)	(0.0007)	(0.0006)
Host Country is Spain	-0.023	-0.023***	-0.121	-0.121***
	(0.0269)	(0.0075)	(0.1031)	(0.0406)
Host Country is Italy	-0.0098	-0.009	-0.036	-0.036
	(0.0527)	(0.0102)	(0.2057)	(0.0443)
Host Country is Other (27 more)	-0.208***	-0.208***	-0.059	-0.059
	(0.0512)	(0.0730)	(0.2745)	(0.2178)
Migrant is not a Close Relative	-0.238***	-0.238***	-0.273**	-0.273**
	(0.0301)	(0.0444)	(0.1320)	(0.1088)
Left for Studying or Unifying Family	-0.149***	-0.149***	-0.440***	-0.440*
	(0.0336)	(0.0551)	(0.1454)	(0.2203)
Years of Schooling	-0.004	-0.004	0.044***	0.044***
	(0.0029)	(0.0032)	(0.0115)	(0.0085)
Constant	0.756***	0.756**	5.528***	5.528***
	(0.2537)	(0.3140)	(0.1975)	(0.0629)
Observations	1529	1529	952	952
Pseudo R^2	0.0868	0.0868		
R-squared			0.1194	0.1194

Data Source: 2004 Demographic, Maternal and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. While columns (1) and (3) report robust standard errors, columns (2) and (4) report cluster-robust standard errors at the migrant host country level. Coefficients of the logit model are the average marginal effect (AME), which are computed using the added stata command $margeff$. * significant at 10%, ** significant at 5%, and *** significant at 1%.

Table 2.6: Determinants of Remittance Behavior in Ecuador: Equal to 1 if Migrant Remits for the Logit Model and the Log of Individual Migrant Remittances per Household Member (Receivers) in U.S. Dollars for the OLS Model

Variable	**Two Part Model**			
	Logit Model (AME)		**OLS Model**	
	(1)	**(2)**	**(3)**	**(4)**
A. Household Characteristic				
Household has 2 Migrants	-0.051*	-0.051	-0.436***	-0.436***
	(0.0298)	(0.0451)	(0.1122)	(0.0431)
Household has 3 Migrants	0.016	0.016	-0.461***	-0.461***
	(0.0390)	(0.0612)	(0.1509)	(0.0909)
Household has 4 Migrants	-0.137***	-0.137***	-0.367**	-0.367***
	(0.0428)	(0.0441)	(0.1458)	(0.1127)
Household has 5 Migrants	-0.037	-0.037	-0.894***	-0.894***
	(0.0535)	(0.0446)	(0.1943)	(0.3011)
1 if Household Head is Female	0.114***	0.114***	0.669***	0.669***
	(0.0250)	(0.0136)	(0.0923)	(0.1373)
Ratio of Children to Adults	0.002***	0.002***	-0.008***	-0.008***
	(0.0006)	(0.0007)	(0.0026)	(0.0015)
B. Migrant Characteristics				
Length since Migration	0.019**	0.019***	-0.061***	-0.061**
	(0.0089)	(0.0047)	(0.0226)	(0.0234)
Length since Migration Squared	-0.001*	-0.001***	0.002***	0.002***
	(0.0004)	(0.0001)	(0.0007)	(0.0006)
Host Country is Spain	-0.0170	-0.017**	-0.152	-0.152***
	(0.0268)	(0.0078)	(0.1045)	(0.0406)
Host Country is Italy	-0.0042	-0.0042	-0.047	-0.047
	(0.0521)	(0.0128)	(0.2058)	(0.0487)
Host Country is Other (27 others)	-0.200***	-0.200***	-0.090	-0.090
	(0.0521)	(0.0748)	(0.2805)	(0.2233)
Migrant is not a Close Relative	-0.2469***	-0.246***	-0.256*	-0.256**
	(0.0300)	(0.0408)	(0.1342)	(0.1121)
Left for Studying or Unifying Family	-0.152***	-0.152***	-0.419***	-0.419**
	(0.0335)	(0.0484)	(0.1449)	(0.1894)
Years of Schooling	-0.003	-0.003	0.044***	0.044***
	(0.0028)	(0.0037)	(0.0116)	(0.0102)
Constant	0.614**	0.614*	5.447***	5.447***
	(0.2403)	(0.3649)	(0.1939)	(0.1165)
Observations	1529	1529	952	952
R-squared			0.1271	0.1271
Pseudo R^2	0.0914	0.0914		

Data Source: 2004 Demographic, Maternal and Infant Health Survey, Center of Population Studies and Social Development, Ecuador. While columns (1) and (3) report robust standard errors, columns (2) and (4) report cluster-robust standard errors at the migrant host country level. Coefficients of the logit model are the average marginal effect (AME), which are computed using the added stata command $margeff$. * significant at 10%, ** significant at 5%, and *** significant at 1%.

3 Human Capital Consequences of Civil War: Evidence from Guatemala (with Rubiana Chamarbagwala)

3.1 Introduction

The microeconomic impact of war on civilian populations can be substantial and persistent. Not only can people living in war zones suffer injuries and have their property destroyed, they may also be displaced from their homes, lose their means of survival, or be unable to attend school, all of which may result in a permanent decline in their productivity and earnings. Understanding which economic consequences of conflict are more profound or persistent is important for implementing post-conflict reconstruction effectively. Moreover, since war costs tend to be disproportionately borne by the poor and most vulnerable populations, conflict may intensify poverty and inequality (Quinn et al. 2007). Thus, evidence of the negative consequences of war can help identify those populations that reconstruction policy should target. This paper examines how Guatemala's 36-year-long civil war between 1960 and 1996 affected human capital accumulation of individuals exposed to it and which demographic groups were worst affected.

There is a large literature that examines the aggregate effects of armed conflict on investment, income, and growth.[1] One set of studies finds that populations quickly recover back to pre-war trends. Cities that experienced heavy bombing during World War II were

[1] See Blattman & Miguel (2008) for an extensive survey of the causes and effects of civil war.

indistinguishable from those that were not bombed 20 to 25 years after the war in Japan (Davis & Weinstein 2002) and in Germany (Brakman et al. 2004). After the Vietnam War, Miguel & Roland (2005) find that physical infrastructure, education, and poverty levels all converged across regions within 25 years.

The cross-country literature also finds rapid recovery of postwar economies (Organski & Kugler 1977, 1980, Przeworski et al. 2000). Compared to currency crises, banking crises, and sudden shifts in executive power, Cerra & Saxena (2008) find that while civil wars cause the largest short-run fall in output (six percent on average), output also rebounds quickly only in the case of civil war, recovering half of the fall within a decade. In countries affected by civil war, economic, social, and political development are also found to improve steadily after a war (Chen et al. 2008). Evidence on the short-run effects of war and violence also exists. Abadie & Gardeazabal (2003) find that terrorist violence in the Basque region of Spain significantly reduced economic growth relative to it's neighboring regions. Justino & Verwimp (2006) find that 20 percent of the Rwandan population moved into poverty after the genocide. In a study of African countries affected by internal armed conflicts, Stewart et al. (2001) find that primary school enrollments decreased in only three out of eighteen countries, but improved in five during civil conflicts and that on average, girls fared better than boys since boys often serve in the army.

The recent availability of data from war regions has resulted in a growing empirical literature that estimates the microeconomic effects of war on income, poverty, wealth, health, and education, for both combatants and civilians. The long-term health effects of war appear to be significant. Alderman et al. (2004) find that young children who suffered from war-related malnutrition in Zimbabwe are significantly shorter as adults and that this may affect their lifetime labor productivity. Akresh et al. (2007) find a negative relationship

between height-for-age z-scores and exposure to the Rwandan civil war, the effect being particularly strong for girls. In a similar paper, Akresh et al. (2009) find that an additional month of war exposure in rural Burundi decreases children's' height-for-age z-scores compared to non-exposed children.

There is growing body of research that estimates the impact of war on schooling and labor market outcomes. Examining the effect of Uganda's civil conflict on combatants, Blattman & Annan (2007) find that male youth who were recruited into armed groups received less schooling, are less likely to have a skilled job, and also earn lower wages. de Walque (2006) finds that individuals with an urban, educated background are more likely to have died during the Cambodian genocide period of 1975-1978 and as a result, males of school age during that period have less education than previous or subsequent cohorts. Akresh & de Walque (2008) find a strong negative impact of the Rwandan genocide on schooling, with children exposed to the civil war experiencing an 18.3 percent decline in their average years of education. The authors find a stronger negative effect for males and for the non-poor. For Central Asia, Shemyakina (2006) finds that adolescent Tajik girls whose homes were destroyed during the civil war are less likely to obtain secondary education and that this affects their wages. Unlike Stewart et al. (2001), de Walque (2006), and Akresh & de Walque (2008), Shemyakina (2006) finds that the civil war in Tajikistan only decreased school enrollments of 12-16 year old girls living in high conflict intensity areas but had no significant impact on the education of boys or younger children.

In this paper, we examine the impact of Guatemala's 36-year-long civil war (1960-1996) on childrens human capital accumulation. Even though the civil war lasted 36 years, the worst period of the war began in 1979 and ended in 1984, during which over 90 percent of the total human rights violations were committed. According to the Commission for His-

torical Clarification (CEH) and Recovery of Historical Memory Project (REMHI), roughly 200,000 individuals lost their lives or disappeared, more than 500,000 people or 8.3 percent of the 1983 population were displaced, and many Mayan villages were completely destroyed as a result of the civil war (Commission for Historical Clarification 1999, Archdiocese of Guatemala 1999, Perera & Chauche 1995)[2]. Of the cases of human rights violations documented by the CEH, 83 percent of fully identified victims were Mayan and 17 percent were Ladino.[3] The civil war in Guatemala began as a military rebellion that intensified during the 1970s. The period between 1960 and 1978 was relatively peaceful, until the worst period of the war began in 1979 and lasted until 1984. From 1985 onwards, the violence declined rapidly, until the war ended in 1996. Most human rights violations were committed by the state against the civilian population and left a large number of children orphaned and abandoned. Families and communities lost property and their means of survival. The increase in military spending diverted necessary investments of public resources away from health and education, resulting in the abandonment of social development.[4] This accelerated the deterioration of health and educational conditions in those areas most severely affected by the confrontation. In addition, the destruction of physical assets, including private and community property, and the loss of infrastructure, such as bridges and electrical towers, also represented considerable losses and amounted to over 6 percent of the country's 1990 gross domestic product. These material losses frequently involved the total destruction of family capital, especially among Mayan families, and particularly in the west and north-west

[2]The CEH was sponsored by the United Nations whereas the REMHI was sponsored by the Archdiocese of Guatemala.

[3]According to the Guatemalan population census of 2002, 41 percent of the total population was self-identified as Mayan and 59 percent was self-identified as Ladinos. Mayan refers to the native or indigenous population and Ladinos are a socio-ethnic category that, in the Guatemalan case, represents a mix between Spanish and Mayans.

[4]In 1985, public investment in physical capital reached its lowest level in the last 40 years and represented only 2 percent of the country's GDP.

of Guatemala.

Given the length of the war, the economic consequences are estimated to be severe. Based on its investigation of the economic costs of the armed confrontation and taking only the 10-year period between 1980 and 1989, the CEH estimates that the total direct quantifiable costs were equivalent to zero production in Guatemala for almost 15 months, equal to 121 percent of the country's 1990 GDP. The majority of the costs resulted from the loss of production potential due to the death, disappearance, or forced displacement of individuals who had to abandon their daily activities or from recruitment into the Patrullas de Autodefensa Civil (PAC), the Army, or the guerrillas. The destruction of physical assets, including private and community property, and the loss of infrastructure also represented considerable losses. These material losses frequently involved the total destruction of family capital, especially among Mayan families, and particularly in the west and north-west of Guatemala.

We use the 2002 National Population Census and the distribution of the number of human rights violations and victims across departments to examine the magnitude of the war's effect on years of schooling and grade completion. Even though previous studies have examined the effect of civil war on schooling, this paper contributes to the literature in three important dimensions. First, Guatemala's civil war is unique in that it lasted 36 years and had three distinct periods with varying levels of war intensity. This allows us to examine the schooling outcomes of three cohorts who may have been differentially affected by the war, as illustrated in Table 3.1. The first cohort was school age during the initial, relatively peaceful period (1960-1978), the second cohort was school age during the worst period of the war (1979-1984), and the third cohort was school age during the latter part of the war (1985-1996), which again was relatively peaceful. We therefore expect a small impact

of the war on the education of the first and third cohorts but a fairly large effect on the schooling of the second cohort. Our empirical strategy enables us to assess the long-term and incremental effects of internal conflict, which is not possible with most civil wars since they last a relatively short period of time.

Second, we estimate the effect of the war on schooling outcomes for eight demographic groups based on gender, urban-rural residence, and ethnicity in order to identify those groups that were most affected by the war. This is particularly relevant since most civil wars target specific ethnic groups and as a result may affect various demographic groups differently. Moreover, since these eight groups generally represent varying levels of wealth, we can examine the effect of the war on more socio-economically privileged groups, namely urban non-Mayans, as well as on socially excluded and poorer groups, namely rural Mayans.[5] Since the majority of human rights violations occurred against the Mayan population in rural areas, we expect that the civil war in Guatemala may have disproportionately affected the schooling of rural Mayan children.

Finally, we include an analysis of schooling outcomes for a cohort who was school age for each of grades 1 to 6 during post-war years, that is from 1997 onwards. Since the war ended in December 1996 and our data comes from the 2002 Census, we observe individuals who were old enough to have had the opportunity to complete grades 1 to 6 after the war ended. By comparing grade completion of these post-war cohorts to those who were primary school age during the latter period of the war, we examine the speed of post-war recovery in terms of education.

We find a strong negative impact of the civil war on the education of rural Mayan males and females, which supports the conclusion that internal armed conflict reinforces

[5]According to the poverty reduction strategy report (Secretaria Planificacion y Programacion 2006), 31 percent of Mayans and 14 percent of non-Mayans had an income less than $1 in 1989.

poverty and social exclusion among the most vulnerable groups. Among rural Mayan males, those who were school age during the three periods of the civil war in departments where more human rights violations were committed completed 0.27, 0.71, and 1.09 years less of schooling respectively whereas rural Mayan females exposed to the three periods of the war completed 0.12, 0.47, and 1.17 years less of schooling respectively. Given an average of 4.66 and 3.83 years of schooling for males and females, these represent declines of 6, 15, and 23 percent for males and 3, 12, and 30 percent for females. Our results are robust to the inclusion of indicators for department of residence, year of birth, and controls for different trends in education and human development in war affected and peaceful departments of Guatemala. Examining grade completion, we find that it was primarily due to a lower likelihood of completing primary school grades that rural Mayan males and females received less schooling as a result of the war. This result is not surprising since only 25 percent of the population in Guatemala receive more than a primary education. Finally, we find that rural Mayan males and females who were primary school age during post-war years in higher war intensity departments were more likely to complete each of grades 1 through 6 or higher, suggesting that at least primary school outcomes improved immediately after the war for the two groups most affected by it.

Our results show that Guatemala's civil war had a negative impact on the human capital accumulation of two of the most vulnerable demographic groups and may have lowered the adult wages and labor productivity of these individuals. That rural Mayan children who were school age during the final, relatively peaceful period of the war received less schooling than those who were school age during the most violent period is an interesting finding, for which we provide two possible explanations. First, the war may have resulted in long-term poverty among rural Mayans which lasted well after the violence declined. The sheer length

of the war may have progressively worsened the poverty of vulnerable groups over time. Second, children in our sample who were school age during the latter period of the war may include individuals whose parents were displaced from their homes. If these displaced families remained in or moved to higher war intensity departments and if their children were born after they were displaced, then the education of these children may have been most severely affected by the war. Since the majority of displacements occurred among rural Mayans during the worst period of the war (1979-1984), children in our sample who were born in 1978-1983 and were school age in 1985-1996 may include a large number from displaced families. Given that the loss of property and means of livelihood was greatest for displaced families, it is likely that the poverty of these families was most severely affected by the war. Therefore, it is not surprising that educational outcomes are worst for rural Mayan children who were school age during the latter period of the war.

Guatemala's 36-year-long civil war appears to have intensified gender, regional, sectoral, and ethnic disparities in human capital accumulation. As Table 3.2 shows, among individuals born between 1920 and 1983, average schooling is 2.27 years higher in the 17 lowest war intensity departments compared to the top five high war intensity departments, 3.74 years higher in urban than in rural areas, and 3.15 years higher among non-Mayan than Mayan people. Gender differences also exist, with female education lagging behind male education throughout the entire country but especially in high war intensity departments and among Mayans. Despite the negative consequences of the war, however, primary school outcomes of the worst affected groups improved among cohorts who were school age during post-war years. While this finding is encouraging, we cannot be certain that this improvement continued over time.

This paper is structured as follows. Section 3.2 describes the historical context and

impact of the civil war. Section 3.3 describes the data and empirical identification strategy. Section 3.4 presents the results and Section 3.5 concludes.

3.2 Civil War in Guatemala

3.2.1 Political History

Located in Central America, Guatemala borders Mexico to the north and west, the Pacific Ocean to the southwest, Belize and the Caribbean Sea to the northeast, and Honduras and El Salvador to the southeast. With a current population of 13,002,206. The country consists of 22 geographical departments, which in turn consist of 331 counties. More than half of Guatemalans are descendants of indigenous Mayans and a substantial proportion of the population are of mixed European and indigenous ancestry and are known as Ladinos. Most of Guatemala's population is rural, though urbanization is accelerating. The predominant religion is Roman Catholicism, into which many indigenous Guatemalans have incorporated traditional forms of worship. Between 1960 and 1996, the country experienced a 36-year civil war, the worst period of which occurred between 1979 and 1984.

After Spanish colonial rule for 300 years, Guatemala gained independence from Spain in 1821. An authoritarian state was then created which excluded the indigenous population, was racist in its precepts and practices, and served to protect the economic interests of the privileged minority. The state gradually evolved as an instrument for the protection of the concentration of productive wealth in the hands of the non-Mayan population, guaranteeing the continuation of social exclusion and injustice, which led to protest and political instability. Faced with movements proposing economic, political, social, or cultural change, the state increasingly resorted to violence and terror in order to maintain social control.

Among the potential causes of the Guatemalan civil war was the chronic status quo of

inequality and social exclusion that was inherited from the colonial period (Commission for Historical Clarification 1999, Archdiocese of Guatemala 1999, Perera & Chauche 1995). For example, in Quiché, the department most affected by the civil war and where almost 100 percent of the population is Mayan, by 1964 90 and 97 percent of households did not have access to water and electricity, respectively.[6] Other factors that may have played a relevant role in the Guatemalan civil war was the global cold war confrontation and U.S. economic interests. With the support of the CIA an authoritarian right-wing government was installed in 1954, after overthrowing the popular elected liberal president Jacobo Arbenz. This liberal president had started an extensive land reform program in 1952, which adversely affected big land owners and favored mainly Mayan and poor Ladinos. After six years of authoritarian rule from 1954 to 1960, a group of junior military officers revolted in 1960. When they failed, several went into hiding and established close ties with Cuba, forming the first guerrilla group. This group became the nucleus of the forces that were in armed insurrection against the government for the next 36 years. Throughout the armed confrontation, insurgent groups adopted Marxist doctrine. On December 29 1996, the Government of President Alvaro Arzú Irigoyen, together with the Guatemalan National Revolutionary Unity (URNG), with the participation of the United Nations as moderator and with the support of the international community, concluded a long negotiating process, by signing the Peace Accords.

The CEH found that state forces and related paramilitary groups were responsible for 93 percent of the violations documented by the CEH, including 92 percent of the arbitrary executions and 91 percent of forced disappearances. Victims included men, women and children of all social strata: workers, professionals, church members, politicians, peasants,

[6]This data is from the National Population Census of 1964.

students and academics; in ethnic terms, the vast majority were Mayans. According to the CEH, 83 percent of fully identified victims were Mayan and 17 percent were Ladino.

Between 1962 and 1970, victims were mainly peasants, members of rural union organizations, university and secondary school teachers and students, and guerrilla sympathizers. Between 1971 and 1978, military operations were more selective and geographically dispersed. Victims included community and union leaders, catechists, and students. During the most violent and bloody period of the entire armed confrontation, 1979 to 1984, military operations were concentrated in Quiché, Huehuetenango, Chimaltenango, Alta and Baja Verapaz, the south coast, and the capital. During this period, 91 percent of the total human rights violations were committed, the victims being mainly Mayan and to a lesser extent Ladino. Figure 3.2, which shows the number of human rights violations committed by the state and guerrillas over the 1960-1996 period, reveals the sharp increase in these violations between 1979 and 1984. Figure 3.3 shows the geographical distribution of the victims of the civil war across Guatemala's 22 departments. With almost 96 victims per 1000 population, Quiché experienced the worst of the war, followed by Baja Verapaz, Alta Verapaz, Petén, and Huehuetenango. During the final period, 1985 to 1996, operations were selective and affected the Mayan and Ladino population to a similar extent.

3.2.2 Civilian Impacts of the War

Civil war can affect human capital accumulation through several channels. First, the forced displacement of families as well as the loss of income-earning members in families may reduce resources available to many households. In order to maintain certain consumption levels, resources may be drawn away from schooling and towards more basic needs such as food, shelter, clothing, and health. During the Guatemalan civil war, estimates of the

number of displaced people vary from 500,000 to a million and a half people in the most intense period from 1981 to 1983, all of whom lost relatives and property. Moreover, the armed confrontation left a large number of children orphaned, abandoned, and their families destroyed. Thus, it is likely that children were removed from schools and possibly even made to engage in domestic or market work.

Second, infrastructure, such as schools and educational facilities, may be destroyed and teachers may be killed. As a result, children may have to travel long distances to attend school or stop attending school entirely. Third, since civilians are often the victims of armed forces and militias, parents may withdraw their children from school in order to keep them safe. A large number of children were among the direct victims of arbitrary execution, forced disappearance, torture, rape, and other violations of their fundamental rights during the civil war in Guatemala. This may have induced parents to stop sending their children to school. Finally, the expected returns to schooling may fall as a result of civil wars, which may discourage parents from sending their children to school. The destruction of existing industries and lack of creation of new industries may result in a scarcity of skilled jobs, making parents redistribute household resources away from individuals with lower expected returns and toward those with higher ones.

Armed conflict may have a stronger impact on certain groups of individuals. While previous analyses of school enrollments have found that males fare particularly badly since they are more likely to become combatants (Stewart et al. 2001, de Walque 2006, Akresh & de Walque 2008), it is also possible that the most vulnerable groups in the population may be affected the most. For example, Shemyakina (2006)'s study finds that females rather than males received less secondary education in Tajikistan as a result of the civil war. In this paper, we find that Guatemala's civil war had a strong negative effect on the

education of the two most disadvantaged groups – rural Mayan males and females. Thus, the war appears to have deepened the poverty of the poorest groups, which affected their schooling. In addition, rural Mayan males may have been more likely to engage in conflict and therefore less likely to attend school. Females, on the other hand, may have been affected for different reasons. Since girls in Guatemala receive less schooling on average, get married at an early age, and usually engage in household chores and child rearing rather than market work, they may be more likely to receive less schooling than boys, especially when resources become scarce. Parents may also withdraw their daughters from school in order to protect them from being sexually assaulted, raped, and harassed.

Unlike many other civil wars, the war in Guatemala lasted 36 years. Thus, the effect of Guatemala's civil war on human capital accumulation may be very different from other shorter wars. The loss of property and means of livelihood, the destruction of entire communities and villages, and the forced displacement of families over a 36-year period may have created several generations of individuals with deep-rooted poverty and inferior health and educational outcomes. The post-war recovery of these and subsequent generations may therefore have been slow and difficult. We find that schooling among rural Mayan males and females deteriorated even more during the latter period of the war than during the worst period. This indicates that the war may have resulted in long-term poverty among rural Mayans which lasted well after the violence subsided.

3.3 Data and Estimation

3.3.1 Data

In this paper we attempt to measure the effect that Guatemala's civil war had on the educational achievements of cohorts who were exposed to the three periods of the war, namely

the initial period (1960-1978), the worst period (1979-1984), and the latter period (1985-1996). We use several sources of data for this study. Two data sources provide information on the geographical intensity of the civil war in Guatemala. The first source is from the Commission of Historical Clarification and provides the number of human rights violations and acts of violence across the country's 22 departments (Commission for Historical Clarification 1999). The second data source is from the Recovery of Historical Memory Project and provides the number of victims in each of the country's 22 departments (Archdiocese of Guatemala 1999). Using the total population in each department from the 1983 National Population Census, the year closest to the 1979-1984 period, we calculate the number of victims and human rights violations relative to the population in these departments.[7] As can be seen in Figure 3.3, the six departments with the highest number of victims per 1000 population include Quiché, Baja Verapaz, Alta Verapaz, Petén, Huehuetenango, and San Marcos. The highest number of human rights violations per 1000 population occurred in Quiché, Baja Verapaz, Huehuetenango, Alta Verapaz, Chimaltenango, and Petén. We categorize as high war intensity departments the five departments that fall in both categories – namely, Quiché, Baja Verapaz, Alta Verapaz, Petén, Huehuetenango – and the remaining 17 departments as low war intensity.

Our third source of data is the 2002 National Population Census, which was published by the Instituto Nacional de Estadistica, Guatemala. From the 2002 Census we get information on an individual's birth year, demographic characteristics, schooling, department of birth, and department of residence in December 1996, when the peace accord was signed. Due to the massive population displacement that occurred during the civil war, we restrict our analysis to individuals who had the same department of birth and department of residence

[7]The 1983 Census was administered and published by the Dirección General de Estadísticas, Guatemala.

at the time of the signing of the peace accord in December 1996, which allows us to identify an individual's department of schooling.[8] Even though many of the individuals in this restricted sample consist of non-displaced or non-migrant people, it is possible that some individuals in this sample may have been born after their parents were displaced during the war. This is especially true for individuals born during the worst period of the war, when the majority of forced displacements occurred. Therefore, our sample most likely includes non-displaced as well as displaced individuals, the latter group comprising younger cohorts, especially those born in or after 1979 when the most violent period of the war began.

In order to allow for completion of schooling by 2002, we include individuals who were born between 1920 and 1983. The youngest cohort – i.e. those who were born in 1983 – were 19 years old in 2002 and therefore had the opportunity to complete high school by the time of the 2002 census.[9] Figures 3.4 and 3.5 show the average years of schooling for five different cohorts of eight demographic groups in high and low war intensity departments. The first two cohorts consist of individuals born between 1920 and 1930 and between 1931 and 1941, all of whom were at least 19 years old at the start of the war in 1960 and therefore not exposed to the civil war during their school age. The last three cohorts consist of individuals who were school age during the three periods of the war. Individuals born between 1942 and 1960 were school age during the initial, relatively peaceful period of the war (1960-1978) since they were at least 19 years old in 1979. Individuals born between 1961 and 1977 were school age during the worst period of the war (1979-1984) during some or all of their primary, secondary, and high school years. The eldest children in this cohort were 18

[8] This restriction has two potential problems, which we address in Section 3.4.3.

[9] We top code an individual's years of schooling to 12 years, that is we assign 12 years of schooling even to individuals who completed more than 12 years by attending college, who constitute only 5 percent of our sample. In Guatemala, primary school consists of grades 1 to 6, secondary school of grades 7 to 9, and high school includes grades 10 to 12. Children usually attend primary school when they are between 7 and 12 years old, secondary school when they are 13 to 15 years old, and high school when they are between 16 and 18 years old.

years old in 1979 whereas the youngest children were 7 years old in 1984. Individuals born between 1978 and 1983 were school age during the latter part of the war (1985-1996) which again was a relatively peaceful period.

As Figures 3.4 and 3.5 show, educational attainment improved over time for all eight demographic groups in both high and low war intensity departments. This increase in educational attainment reflects the general tendency in developing countries for schooling outcomes to improve over time and suggests that children who were school age during the civil war did not attain less schooling on average than their older cohorts. Another characteristic of schooling in poor countries is that there tends be convergence in schooling outcomes between less and more educated regions and groups over time. In Guatemala, we see a pattern of regional convergence for the more privileged groups, namely urban non-Mayan males and females. However, for the less privileged groups, such as rural Mayan males and females, there is a widening divergence between high and low war intensity departments, which may have been the result of the civil war.

From the 1964 National Population Census, we obtain information on three key variables that measure the level of education and human development in the country's 22 departments at the start of the civil war.[10] We use the enrollment rate of 7 to 17 year old children to measure initial levels of schooling and the proportion of households without access to water and electricity to measure differences in the provision of basic services. We use this information to control for different trends in education and human development across departments.

[10]The 1964 Census was administered and published by the Dirección General de Estadísticas, Guatemala.

3.3.2 Empirical Analysis

The year of birth and the department of birth jointly determine an individual's exposure to the civil war. The identification strategy therefore exploits variation in the war's intensity across departments and which cohorts were school age during the three periods of the war, which can be illustrated using difference-in-differences tables. In Tables 3.3 and 3.4, we show the average years of schooling for eight demographic groups who were school age during the three periods of the civil war – those born in 1942-1960, 1961-1977, and 1978-1983 – and individuals who had completed school age by 1960 – those born in 1920-1941. Columns 1 and 2 show the average years of schooling for these groups in the 5 high war intensity departments (HWI) and 17 low war intensity departments (LWI), respectively.

Educational attainment is higher for younger cohorts compared to older ones in both high and low intensity war departments. This is true for all eight demographic groups and is consistent with the increasing trend in educational attainment that is observed in most developing countries. Further, schooling in high war intensity departments is lower than that in low war intensity departments for all cohorts in all groups. The difference-in-differences calculation shows statistically significant increases of 0.34, 0.36, and 0.59 years of schooling for each successive cohort exposed to the war compared to the unexposed cohort among the most privileged group, namely urban non-Mayan males. A similar pattern is found for urban non-Mayan females, with each successive exposed cohort obtaining 0.20, 0.47, and 0.64 additional years of schooling compared to the unexposed cohort. For all other groups (except urban Mayan males), the difference-in-differences estimate is increasingly negative for each successive cohort. Rural Mayan females are the worst affected group, with each successive exposed cohort obtaining 0.17, 0.60, and 0.93 less years of schooling compared to

the unexposed cohort. Rural non-Mayan females, urban Mayan females, and rural Mayan males also appear to be negatively affected by the war.

These results provide preliminary evidence that the educational attainment of certain groups, namely urban non-Mayan males and females, may not have been adversely affected by the civil war. On the other hand, more vulnerable groups and especially those that were targeted as victims appear to have fared particularly badly. The exposed cohort was at least 18 years old in 2002 and had completed their school age by 2002, the Census year. The results in Tables 3.3 and 3.4 therefore show that among disadvantaged groups, exposed cohorts in high intensity war departments did not simply delay their education but actually completed less schooling during their entire school age years.

Tables 3.3 and 3.4 illustrate an empirical identification strategy that relies on the comparison between educational attainment among cohorts who were school age and those who had completed school age by 1960 in low and high war intensity departments. The change in educational attainment between younger and older cohorts in low war intensity departments therefore acts as a control group for what the difference in educational attainment between the cohorts should have looked like in the absence of the civil war. Building on this preliminary analysis, we estimate Equation 3.1.[11]

$$Y_{ijt} = \alpha + \sum_{c=1}^{3} \beta_c War_j * Cohort_t^c + \delta_j + \gamma_t + \varepsilon_{ijt} \tag{3.1}$$

Y_{ijt} is the number of years of education attained by individual i who was born in department j in year t. War_j is a measure of the intensity of the war in department j, which we measure in two alternate ways – the number of human rights violations and the number of victims in a department relative to the population of the department in 1983.[12] $Cohort_t^c$ includes three

[11] This estimation equation is similar to the one used by Duflo (2001). We estimate all regressions with a linear probability model. Alternatively, one can use a logit or probit model, which provide us with consistent results that are available upon request.

[12] Specifically, we use the number of human rights violations per 10 people and alternatively the number

cohorts, namely those born in 1942-1960 ($Cohort_t^1$), 1961-1977 ($Cohort_t^2$), and 1978-1983 ($Cohort_t^3$), with individuals born between 1920 and 1941 being the omitted group. The interactions of a department's war intensity with each of these three cohorts are the key variables of interest and measure an individual's exposure to the war. In order to control for unobserved correlation of observations within departments and for a specific birth cohort, we include department and year of birth fixed effects, δ_j and γ_t respectively. Including department fixed effects purges all observed and unobserved department characteristics that are constant across individuals from the same department, thereby removing any bias that is generated by department characteristics. Year of birth fixed effects control for cohort-specific shocks that may bias our results. ϵ_{icjt} is a random, idiosyncratic error term. Since correlation among the error terms of all individuals in a given location experiencing the same shocks may bias the OLS standard errors downward, all standard errors are clustered by an individual's county (Moulton 1986, 1990, Bertrand et al. 2004).

As discussed in Blattman & Miguel (2008), the validity of difference-in-differences methods to examine the impact of war on microeconomic outcomes relies on the assumption of similar underlying human development trends in war-affected and peaceful regions of countries. The difference-in-differences estimator in Equation 3.1 relies on the assumption that there were similar underlying trends in education and human development in all departments and that in the absence of the civil war, trends in educational attainment would have been similar in all departments. If, however, departments with higher war intensity had systematically lower levels of education and development than departments with lower war intensity prior to the start of the war in 1960, then lower educational attainment of individuals in higher war intensity departments may not reflect the direct impact of the

of victims per 10 people in each department in 1983.

war but instead the declining socio-economic conditions that contributed to the civil war in the first place. Given the availability of census data in 1964, only a few years after the start of the war, we use information on enrollment and access to water and electricity from the 1964 Census to control for different trends in education and human development across departments.

Figures 3.6 and 3.7 plot the enrollment rate and proportion of households without access to water and electricity in a department in 1964 against the rank of each department with respect to the number of human rights violations and victims per 1000 population. The positive relationship between enrollment rates and war intensity shows that departments with a higher enrollment rate in 1964 had a lower number of human rights violations and victims per 1000 population during the civil war. Similarly, the negative relationship between access to water and electricity and war intensity indicates that departments with a higher proportion of households without these services in 1964 had a larger number of human rights violations and victims per 1000 population during the civil war.

These figures show that the level of education and human development in a department are highly correlated with the war intensity in that department and any decline in educational attainment that individuals experienced in higher war intensity departments may be the result of pre-war disparities in development rather than a consequence of the war itself. In Equation 3.1, we therefore include three sets of interactions – those between year of birth indicators and a department's enrollment rate in 1964, those between year of birth indicators and the proportion of households without access to water in 1964, and those between year of birth indicators and the proportion of households without access to electricity in 1964. These interactions explicitly control for different trends in education and human development across departments for individuals born in each year between 1920 and 1983,

the inclusion of which constitutes a contribution of our paper to the existing literature.

3.4 Results

3.4.1 Baseline Difference-in-Differences Estimation

Table 3.5 presents regression results for Equation 3.1 using years of education as the dependent variable. The difference-in-differences estimates are the coefficients of the interaction between each of three cohorts and a measure of war intensity in one's department of birth. The top panel of the table (Panel A) uses the population adjusted number of human rights violations whereas the bottom panel (Panel B) uses the number of victims relative to population to measure civil war intensity in a department. In addition, F-test statistics and their significance levels are presented for three hypotheses that test whether or not the difference-in-differences estimates are statistically significantly different for the three cohorts. Columns (1) to (8) show coefficient estimates and robust, cluster-corrected standard errors from regressions estimated for eight demographic groups. All regressions include fixed effects for an individual's department and year of birth as well as controls for different trends in education and human development across departments.

The difference-in-differences coefficients in Panel A are positive for the two most privileged groups, namely urban non-Mayan males and females, and negative for three of the poorer groups in Guatemala, namely rural Mayan males and females and rural non-Mayan females. For all other groups, the difference-in-differences coefficients are statistically insignificant. Among urban non-Mayan males, the difference-in-differences coefficient is positive for the cohort born between 1942 and 1960 but statistically insignificant for the two younger cohorts who were school age during the worst and latter periods of the war. Thus, within a given department and for an individual of a given age, being of school age in a

higher war intensity department during the initial period of Guatemala's civil war (1960-1978) implies an additional 1.25 years of schooling for urban non-Mayan males. The increase in schooling, however, does not continue for the two younger cohorts among this group who were school age during the worst and latter periods of the war. This suggests that while the civil war did not lower schooling among urban non-Mayan males born between 1966 and 1983, it may have dampened any potential increase in schooling that may have occurred among this group in the absence of the civil war.

We find similar results for urban non-Mayan females, though the difference-in-differences coefficient is positive for the two older cohorts who were school age during the war. Those born between 1942 and 1960 and those born between 1961 and 1977 in higher war intensity departments have respectively 1.15 and 1.32 additional years of schooling. Thus, among this group, even individuals who were school age during the worst period of the civil war in higher war intensity departments obtained more schooling. That the difference-in-difference estimate for the cohort who was school age during the latter period of the war is statistically insignificant, once again suggests that any potential improvements in educational outcomes for this group may have been weakened by the civil war.

Columns (4), (7), and (8) show a negative impact of the civil war for rural Mayan males and rural non-Mayan and Mayan females. Among rural non-Mayan females, the difference-in-differences coefficient is negative only for those born between 1942 and 1960 in higher war intensity departments. For rural Mayan males and females, however, the effect of the civil war is negative and increasingly so for each successive cohort exposed to the civil war in higher war intensity departments. Among rural Mayan males, the three cohorts have 0.27, 0.70, and 1.09 less years of schooling in higher war intensity departments. For rural Mayan females, these figures are 0.12, 0.57, and 1.17. While the difference between β_1 and β_2 are

not statistically significantly different for rural Mayan males, all coefficients are statistically significantly different from each other for rural Mayan females. These results are consistent with the corresponding estimates in Tables 3.3 and 3.4, that were obtained without any controls. The estimates reported in Panel B, where we use the population-adjusted number of victims rather than the number of human rights violations to measure war intensity, are qualitatively similar to those in Panel A, though the magnitude of the coefficients vary.[13]

That we find a negative effect of the civil war on the educational outcomes of rural Mayan children is not surprising for two reasons. First, the urban and non-Mayan population in Guatemala are wealthier and more privileged than the rural and Mayan population. Second, according to the CEH and REMHI, the majority of victims of the civil war were rural and Mayan people (Commission for Historical Clarification 1999, Archdiocese of Guatemala 1999). Our results therefore confirm that the civil war affected the most vulnerable group in Guatemala. While both males and females may receive less education when household property is lost and economic resources become more scarce, males are more likely to become combatants and therefore may attain even less schooling. Females, on the other hand, are more likely to engage in household chores and child-rearing as adults rather than participate in the labor market, making parents redistribute scarce resources away from their daughters' education. In addition, since females are at greater risk of being sexually assaulted, raped, and harassed during a civil war, parents may stop sending their daughters to school.

Perhaps the most interesting finding in Table 3.5 is that rural Mayan cohorts who were school age during the latter, relatively peaceful period of the war obtained even less schooling than those who were school age during the most violent period in higher war

[13]The exception is for rural non-Mayan males. Among this group, individuals who were school age during the worst period of the war in higher war intensity departments (measured by the number of victims relative to the population) have 0.39 additional years of schooling.

intensity departments. We provide two possible explanations for this finding.

First, despite the decline in violence, poverty among the most vulnerable groups may have intensified during the latter period of the civil war. The loss of property and means of livelihood that these groups experienced during the worst period of the war may not have been recovered after the worst period of the war came to an end. Exposure to such a long-term war may have progressively worsened the poverty of vulnerable groups, which may have further deteriorated schooling outcomes. Second, this result may be explained by the inclusion of children of displaced parents in the 1978-1983 cohort. Since the majority of displacements occurred during the worst period of the war (1979-1984) and among rural Mayan populations, if displaced parents gave birth to their children after their displacement, these children would be included in the 1978-1983 cohort of rural Mayan children in our sample. Since these children were school age during the latter period of the war in 1985-1996 and because it is reasonable to expect that the loss of property and means of livelihood was greatest for displaced families, the schooling of these children may have been most severely affected by the war. As discussed in DiGeorgio-Lutz & Hale (2004), the majority of families in conflict affected areas who fled their homes during the early 1980s were displaced in the mountains near their place of origin, thus remaining in departments with higher war intensity. Thus, our sample of children who were born in 1978-1983 and were school age in 1985-1996 may include a large number from displaced families. Therefore, it is not surprising that educational outcomes are worst for rural Mayan children who were school age during the latter period of the war.

That our difference-in-differences estimates are robust to the inclusion of interactions between year of birth indicators and the enrollment rate, availability of water, and availability of electricity in 1964, suggests that our results are not driven by different educational

and human development trends across departments. In order to provide an additional check and more credibility to our estimates, however, we estimate regressions for a control experiment by dividing the pre-war cohorts into 2 groups, that is those born between 1904 and 1919 and those born between 1920 and 1941. In our control experiment, we use the 1904-1919 cohort as the omitted group and include the interaction of War_j with the cohort born between 1920 and 1941. Since individuals born between 1920 and 1941 were at least 19 years old by 1960, their schooling should not have been affected by the war.

In Table 3.6 we present results of the control experiment. The difference-in-differences estimate for the 1920-1941 cohort in both Panels A and B are not statistically significantly different from zero for all eight demographic groups. Thus, there is no systematic difference in the average years of schooling of younger and older cohorts not exposed to the war in higher and lower war intensity departments. These results indicate that the difference-in-differences estimates presented in Table 3.5 are not driven by inappropriate identification assumptions.

3.4.2 Grade Completion

Following the same logic as Table 3.5, Tables 3.7 and 3.8 report results for completion of grades 1 to 12 or higher using the number of human rights violations to measure war intensity whereas Tables 3.9 and 3.10 present results using the number of victims to measure war intensity. Since the results for grade completion are very similar using the number of human rights violations and alternatively the number of victims to measure war intensity, we focus on discussing the first set of results (Tables 3.7 and 3.8). The objective of this analysis is to determine at which level of schooling the civil war had the largest negative impact and for which groups.

Even though the results in Table 3.5 show a positive difference-in-differences estimate among urban non-Mayan males for the 1942-1960 cohort, we find that the difference-in-differences estimate is negative for all three cohorts with respect to completion of grades 1 to 3 or higher. Among this group, the estimate for the 1978-1983 cohort is also negative for completion of grades 4 and 5 or higher. Similarly, despite a positive difference-in-differences estimate for years of schooling for the 1942-1960 cohort among urban non-Mayan females, the estimates are negative for the 1961-1977 and 1978-1983 cohorts for completion of grades 1 to 3 or higher. For completion of grade 6 or higher, the estimate becomes positive for the 1942-1960 cohort among both these groups. Moreover, for completion of grades 7 to 12 or higher, the difference-in-differences estimate is positive for all three exposed cohorts among urban non-Mayans. These results, together with those presented in Table 3.5 show that among the two most privileged groups, average years of schooling increased for exposed cohorts and this increase was due to a greater probability of completing secondary and high school grades (grades 7 to 12) rather than primary school grades. Among urban non-Mayans, however, the youngest children in each exposed cohort appear to have been negatively affected by the war since they were less likely to complete grades 1 to 3 or higher.

For urban Mayan males and rural non-Mayan males, the likelihood of completing the lower primary grades is greater for some exposed cohorts, which does not appear to affect average years of schooling for these individuals, as the results in Table 3.5 show. Among rural non-Mayan females, however, the 1942-1960 cohort is less likely to complete grades 1 to 4 or higher, which is consistent with negative difference-in-differences estimate we find for this group with respect to years of schooling.

For the two groups most negatively affected by the war, we find negative difference-in-difference estimates for exposed cohorts for completion of almost every grade. Among rural

Mayan males, only the 1942-1960 exposed cohort is less likely to complete grades 2 and 3 or higher. However, from grade 4 onwards, the 1961-1977 and 1978-1983 exposed cohorts are also less likely to complete each grade or higher, with the negative difference-in-differences estimate being larger in magnitude for those individuals who were school age during the latter period of the war. The estimates are largest for the last three grades of primary school (grades 4, 5, and 6), followed by secondary school grades (grades 7, 8, and 9). Thus, exposed rural Mayan males completed fewer years of schooling mostly due to their lower likelihood of completing primary and secondary school. Moreover, similar to our findings for years of schooling, the negative effect of the war is strongest for those individuals exposed to the latter period of the war.

For rural Mayan females, the difference-in-differences estimate is negative and large in magnitude for the 1978-1983 cohort for completion of all primary school grades. As discussed in Section 3.4.1, this may be explained by deepening poverty among rural Mayans and the inclusion of children of displaced parents in the 1978-1983 cohort. Even though the difference-in-differences estimates are negative for the other two cohorts, they are not as large in magnitude and are even statistically insignificant for the completion of some primary school grades. For secondary and high school grades, the estimates are fairly small, though still negative for exposed cohorts for most grades. These results indicate that it was mostly due to a lower likelihood of completing primary school grades that rural Mayan females completed fewer years of schooling.

The majority of individuals in Guatemala obtain either no education or some primary education, with less than 25 percent of the population receiving more than primary education. Moreover, completion of primary school is necessary for post-primary education. Therefore, it is not surprising that rural Mayan males and females completed less schooling

on average mostly as a result of their lower likelihood of completing primary school grades.

In order to see whether or not the regressions for grade completion are based on appropriate identifying assumptions, we conduct a control experiment for completion of each grade, similar to what we estimated for years of schooling. The coefficient of the variable (HRV * Born 1920-1941) is reported in Table 3.11 and the coefficient of the variable (Victims * Born 1920-1941) is reported in Table 3.12. The difference-in-differences estimate is negative and statistically significant only for urban Mayan males for completion of grades 1 and 2 or higher and for rural Mayan females for completion of grade 7 or higher. Thus, it is possible that our results are driven by inappropriate identifying assumptions for these three regressions. However, given that less schooling of rural Mayan females is driven mostly by their lower likelihood of completing grades 1 to 6 or higher, our control experiment does not invalidate our main results.

3.4.3 Schooling Outcomes for Displaced or Migrant People

In this section, we examine how restricting our sample to those individuals who had the same department of birth and residence in 1996 may potentially affect our results. This restriction allows us to identify an individual's department of schooling. However, there are two potential problems associated with it.

The first potential problem is that we may falsely identify the birth department of those individuals who temporarily migrated out of their birth department but returned to it before the peace accord was signed in December 1996. This may have happened if, for example, people in high war intensity departments wanted to escape the worst period of the war. If these temporary migrants received more schooling in their place of refuge than they would have in their birth place, we may underestimate the effect of the civil war. On the other

hand, if temporary migrants received less schooling in their place of refuge than they would have in their birth place, we may overstate the direct effect of the war. Even though it is possible that temporary migrants may have returned to their birth place before the war ended, there are several reasons why we believe that return migration before or after even 1996 may not be very likely.

First, it is unlikely that individuals who migrated out of high war intensity departments in order to escape the violence would return before the peace accord was signed in December 1996 since there was no guarantee that the violence had ended before then. Even though the number of displaced people is estimated to be roughly 1 million, only 324,187 of these were resettled by December 1996 and the rest never returned to their original community (DiGeorgio-Lutz & Hale 2004). Second, as discussed in DiGeorgio-Lutz & Hale (2004), when people were displaced from their homes, they did so in groups and thus displacement involved entire communities. Further, because most communities were forced to escape from violent massacres, they lost most of their property and their homes. Thus, most displaced populations did not have homes or property to return to. Further, the destruction of entire villages made it impossible for displaced people to return home. For example, the governments scorched-earth counterinsurgency war in the conflict zones between 1981 and 1983 completely destroyed more than 440 Mayan villages along with the Mayans ability to engage in subsistence agriculture. Third, when complete destruction of villages did not occur, squatter groups occupied and continue to occupy them. Fourth, displaced populations faced serious human rights violations should they attempt to return to their homes because of the stigma of their alleged association as guerrillas or guerrilla sympathizers who were responsible for the armed confrontation. Despite these reasons, it is still possible that some temporary migrants returned to their birth department before December 1996, in which

case we may underestimate or overestimate the effect of the war on educational outcomes. We acknowledge this as a limitation of this paper and it should be considered in evaluating our results.

The second potential problem of our restriction is that we do not examine the effect of the war on displaced people since we cannot identify the department in which they were school age. Since displaced individuals who migrated out of high war intensity departments may have been among the most severely affected by the war, we may underestimate the effect of the war by excluding this group. However, because our data does not include the entire migration history of individuals, we are unable to assess the effect of the war on displaced populations since we cannot identify their department of schooling.

As discussed in Section 3.4.1, our sample may include children who were born after their parents were displaced. Since the majority of displacements occurred between 1979 and 1984, children born after 1979 and therefore included in the cohort of those born between 1978 and 1983 may include the children of displaced parents. Our results show that those born in 1978-1983 had worse schooling outcomes than those born in 1961-1977 even though the latter group was school age during the worst period of the war, which may reflect the inclusion of children of displaced parents in the 1978-1983 cohort. Therefore, even though we restrict our sample to individuals who have the same department of birth and residence in December 1996, it may still include displaced individuals, especially among the 1978-1983 cohort.

Even though some displaced individuals may be included in our sample, our restriction excludes a large number of displaced individuals, especially among older cohorts. In Tables 3.13 and 3.14, we present schooling outcomes for migrants and non-migrants among our eight demographic groups, separately for the top 5 high war intensity departments

(Quiché, Baja Verapaz, Alta Verapaz, Petén, and Huehuetenango) and the 17 low war intensity departments. Migrants are defined as those having a different birth department and department of residence in December 1996 whereas non-migrants are defined as those having the same birth department and department of residence in December 1996. Even though some migrants have slightly worse schooling outcomes among urban non-Mayan males and females, there is little difference between the schooling outcomes of migrants and non-migrants among the two groups most affected by the civil war, namely rural Mayan males and females in high war intensity departments. This shows that rural Mayan males and females from high war intensity departments who migrated or were displaced from their birth place received similar levels of schooling on average than those who remained in their birth place. Thus, it is unlikely that we underestimate the average effect of the war on educational outcomes by excluding migrants or displaced individuals from our sample.

3.4.4 Post-War Schooling Outcomes

In this section, we include an analysis of schooling outcomes for a cohort who was school age for each of grades 1 to 6 during post-war years, that is from 1997 onwards. Table 3.15 describes the sample and cohorts that we use to examine completion of grades 1 to 6 or higher. For completion of grade 1 or higher, we include individuals born between 1978 and 1995. We compare individuals born between 1978 and 1989, who were 7 years old during the latter period of the war, to those born between 1990 and 1995. Individuals born in 1990 were 7 years old in 1997 and therefore old enough to attend grade 1 during the post-war period. Those born in 1995 were 7 years old in 2002 and therefore old enough to be attending grade 1 at the time of the 2002 Census. For completion of grades 2 to 6 or higher, the post-war cohorts consist of individuals born in 1989-1994, 1988-1993, 1987-1992,

1986-1991, and 1985-1990 respectively. School age cohorts for each of grades 2 to 6 during the latter period of the war (1978-1985) consist of those born in 1978-1988, 1978-1987, 1978-1986, 1978-1985, and 1978-1984 respectively. These cohorts were respectively 8, 9, 10, 11, and 12 years old during the latter period of the war.

We estimate Equation 3.2,

$$Y_{ijt} = \alpha + \beta War_j * Cohort_t + \delta_j + \gamma_t + \varepsilon_{ijt}, \tag{3.2}$$

where $Cohort_t$ includes individuals who were the appropriate age for each grade during the post-war period from 1997 onwards. We present the results of these regressions in Table 3.16.

As shown in Panel A, for urban non-Mayan males, there is a greater likelihood of completing grades 1 to 4 or higher for post-war cohorts in higher war intensity departments. Similar results are found for urban non-Mayan females for grades 1 to 3 and for rural non-Mayan females for grades 1 to 4. For the two groups whose education was negatively affected by the war – rural Mayan males and females – there is a greater likelihood of completing each grade among post-war cohorts. Among rural Mayan males, post-war cohorts in higher war intensity departments are between 11 and 13 percentage points more likely to complete grades 1 to 6 or higher whereas for rural Mayan females these figures range from 4 to 13 percentage points. For rural Mayan females, the difference-in-differences coefficient is negative and larger in magnitude for completion of grades 1 to 3 or higher whereas for rural Mayan males, the estimate is fairly similar for all primary school grades. This most likely reflects the fact that more males complete higher grades than females in Guatemala.

Using the number of victims to measure the intensity of the civil war (Panel B) provides similar results, though the magnitude of the coefficients are smaller. These results show that

despite the negative consequences of the war, primary school outcomes of the worst affected groups improved among cohorts who were school age during post-war years. However, since we can only examine primary school outcomes among a few post-war cohorts, we cannot be certain that this improvement continued over time.

3.5 Conclusion and final comments

In this paper, we investigate the impact of Guatemala's 36-year-long civil war (1960-1996) on educational outcomes of individuals. The empirical identification strategy uses a difference-in-differences approach by comparing the difference in the schooling of cohorts who were school age during the three periods of the war with those who had completed school age by 1960 in departments that experienced higher and lower war intensity. Besides including fixed effects for an individuals department of residence and year of birth, we also include interactions between year of birth indicators and the 1964 enrollment rate as well as interactions between year of birth indicators and the availability of water and electricity in a department in 1964. These interactions allow us to control for differences in pre-war levels of education and human development in higher and lower war intensity departments that may have influenced levels and trends in educational attainment in these departments even in the absence of the war.

We find a strong negative impact of the civil war on the education of rural Mayan males and females, which supports the conclusion that internal armed conflict reinforces poverty and social exclusion among the most vulnerable groups. Among rural Mayan males, those who were school age during the three periods of the civil war in departments where more human rights violations were committed completed 0.27, 0.71, and 1.09 years less of schooling respectively whereas rural Mayan females exposed to the three periods of the war

completed 0.12, 0.47, and 1.17 years less of schooling respectively. Given an average of 4.66 and 3.83 years of schooling for males and females, these represent declines of 6, 15, and 23 percent for males and 3, 12, and 30 percent for females. Our results are robust to the inclusion of indicators for department of residence, year of birth, and controls for different trends in education and human development in war affected and peaceful departments of Guatemala. Examining grade completion, we find that it was primarily due to a lower likelihood of completing primary school grades that rural Mayan males and females received less schooling as a result of the war. This result is not surprising since only 25 percent of the population in Guatemala receive more than a primary education. Finally, we find that rural Mayan males and females who were primary school age during post-war years in higher war intensity departments were more likely to complete each of grades 1 through 6 or higher, suggesting that at least primary school outcomes improved immediately after the war for the two groups most affected by it.

Understanding the mechanisms by which civil war affects human capital formation and accumulation is important in formulating effective post-war policies to protect individuals from the negative consequences of wars. While our analysis does indicate some likely mechanisms through which households responded to the civil war, our data does not allow us to address whether or not it was through orphanhood that school age children in higher war intensity departments received less education. As discussed in 3.2.2, civil war can result in the displacement of families and the loss of property and means of livelihood. It can cause the destruction of schools and infrastructure and delay the construction of new schools due to the loss of capital and human resources. It can also heighten security fears, especially for girls. Moreover, the destruction of existing industries and lack of development of new ones may reduce the expected returns to education for both boys and girls. All these factors

may discourage investment in human capital during a civil war and result in low levels of human capital formation and accumulation among individuals exposed to war.

Our results indicate that exposure to Guatemala's civil war had a large, negative, and long-term effect on the education of rural Mayan males and females who were school age between 1960 and 1996. Moreover, each successive cohort exposed to the war during three distinct period of violence and conflict obtained less and less schooling. These results can be explained by a combination of factors. First, Guatemala's 36-year-long civil war increased poverty among one of the poorest groups in the country. Due to the loss of property, their means of livelihood and wealth, and the death of income-earning family members, rural Mayan households may have reallocated limited resources away from educating sons and especially daughters for whom expected returns to education are generally low and security fears are high. In addition, rural Mayan males may have been more likely to become combatants and therefore not attend school.

Second, the finding that cohorts who were school age after the bloodiest period of the war have worse schooling outcomes than those who were school age during the most violent period suggests that even though internal conflict subsided dramatically between 1985 and 1996, the poverty of affected households may have worsened and that this adversely affected educational outcomes. This finding may also be driven by the inclusion of children of displaced rural Mayan households in the cohort exposed to the latter period of the war. Since displaced households most likely experienced the greatest loss of property and income, their children may have fared particularly badly in terms of education.[14]

That the war had a negative impact on the education of males and females among the

[14]Note that our results cannot be explained by the possibility that a large number of educated individuals were killed during the war since rural Mayan males and females constitute the least educated group in Guatemala.

most disadvantaged group shows that it worsened the position of rural Mayans amongst the poorest groups by deteriorating their educational attainment. As Table 3.2 reveals, the war may have reinforced already existing gender, regional, sectoral, and ethnic differences in educational outcomes. Our post-war analysis indicates that at least primary school outcomes improved for rural Mayan males and females who were school age after the signing of the peace agreement in December 1996. While this result provides some evidence of post-war recovery, at least in terms of primary education, we cannot be certain that subsequent cohorts will experience similar improvements nor that existing educational disparities will be narrowed in the near future.

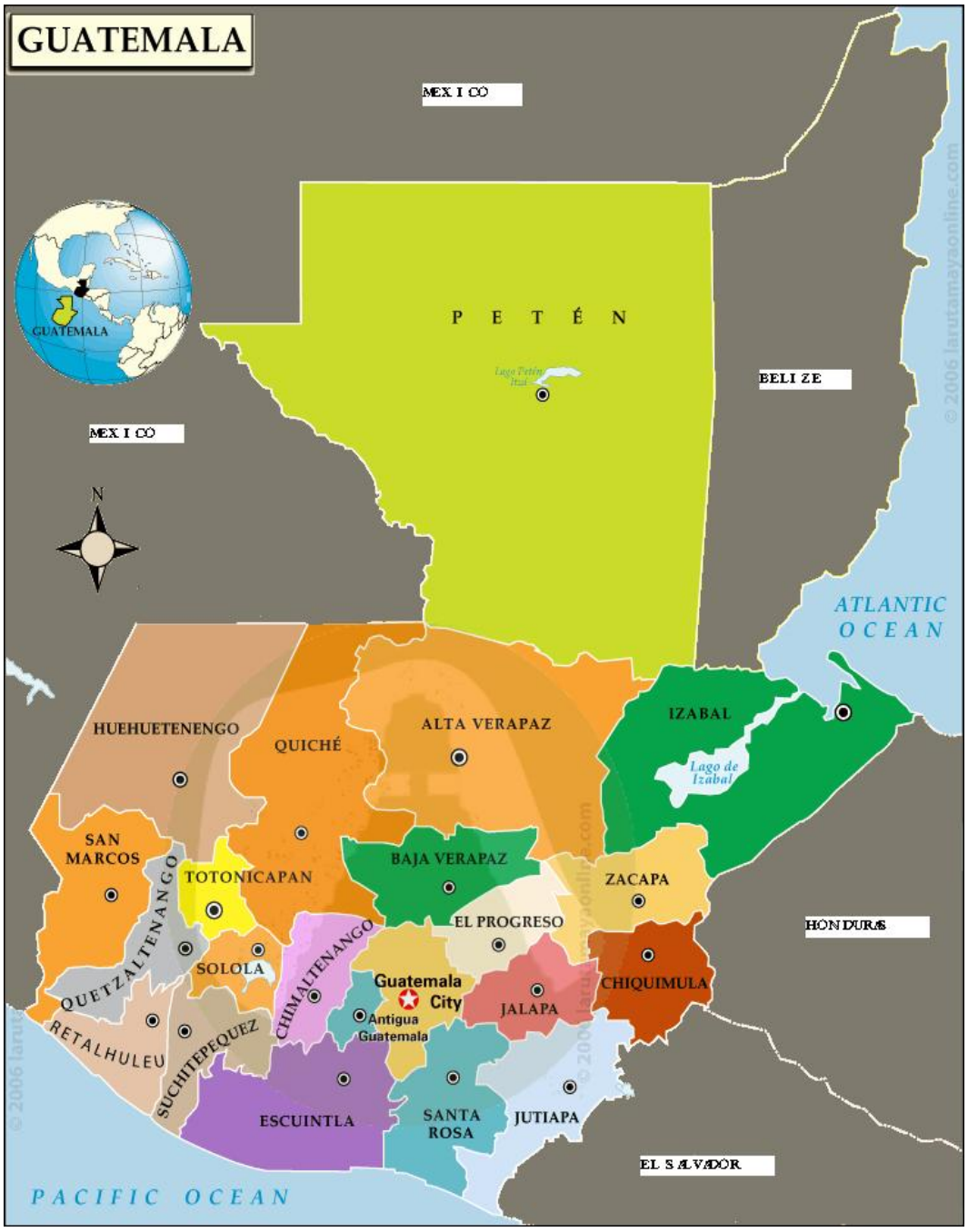


Figure 3.1: Map of Guatemala

Figure 3.2: Number of Killings and Disappearances in Guatemala: 1960-1996

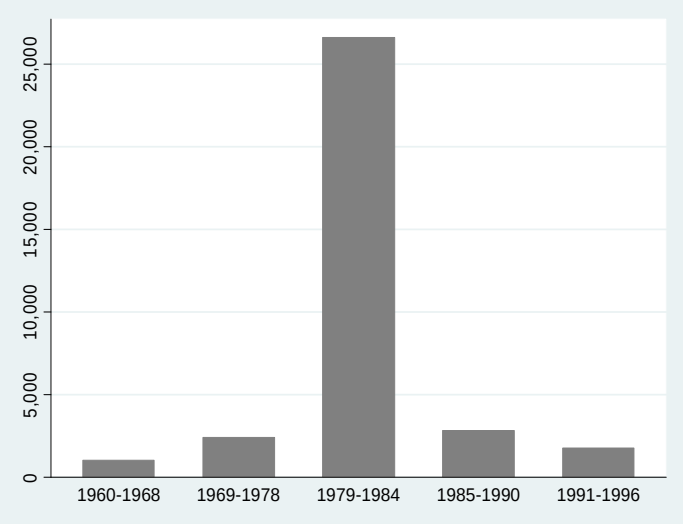


Figure 3.3: Number of Victims and Human Rights Violations Per 1000 Population in Departments

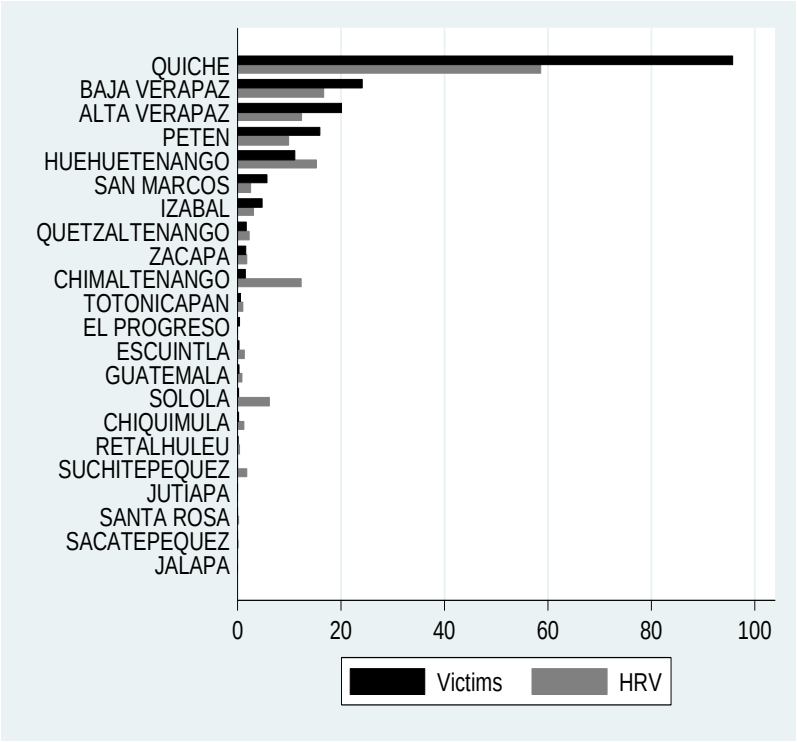


Figure 3.4: Years of Schooling of Males Born Between 1920 and 1983 in High War Intensity (HWI) and Low War Intensity (LWI) Departments

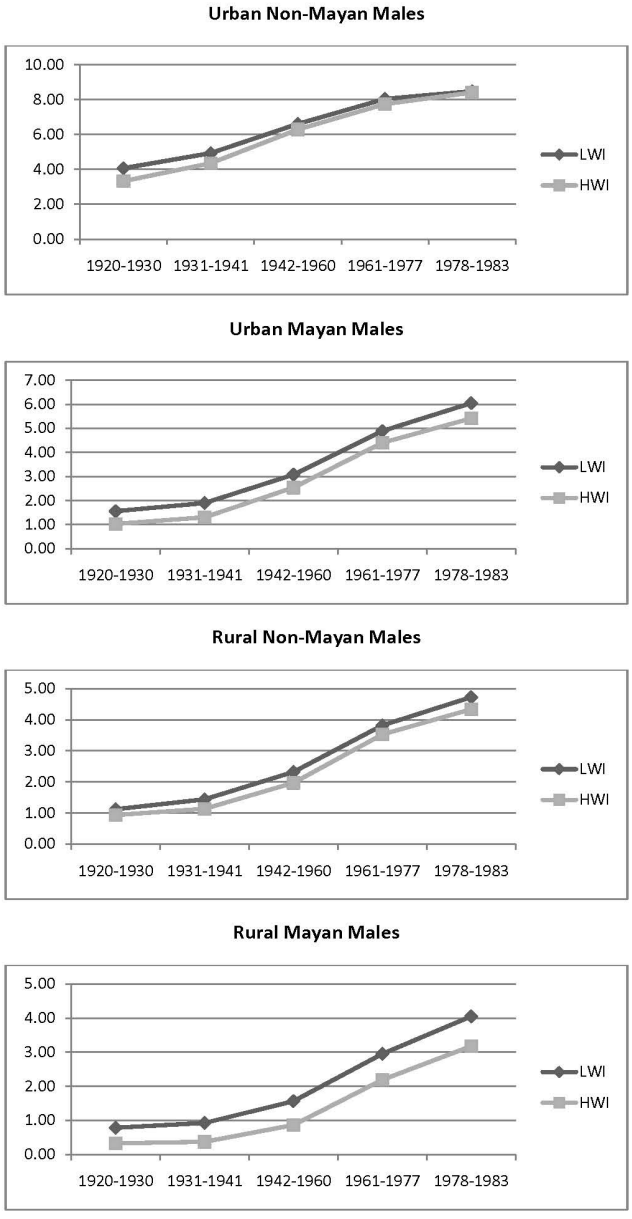


Figure 3.5: Years of Schooling of Females Born Between 1920 and 1983 in High War Intensity (HWI) and Low War Intensity (LWI) Departments

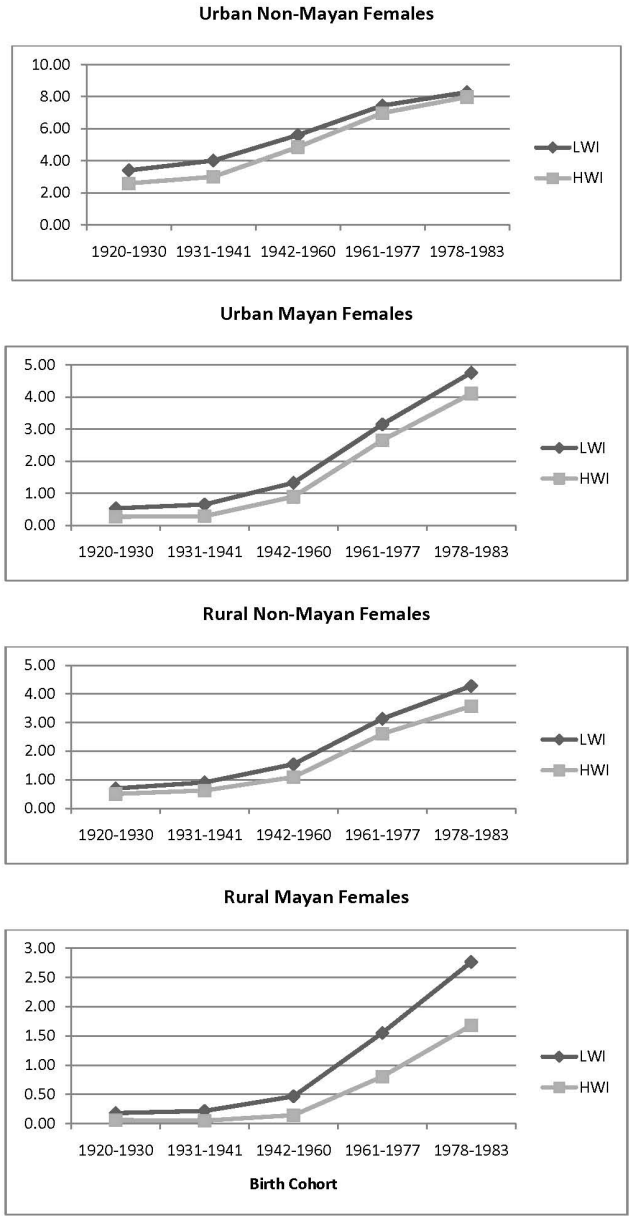


Figure 3.6: 1964 Enrollment Rates, Availability of Water and Electricity in 1964, and Rank of Departments (by Number of Human Rights Violations)

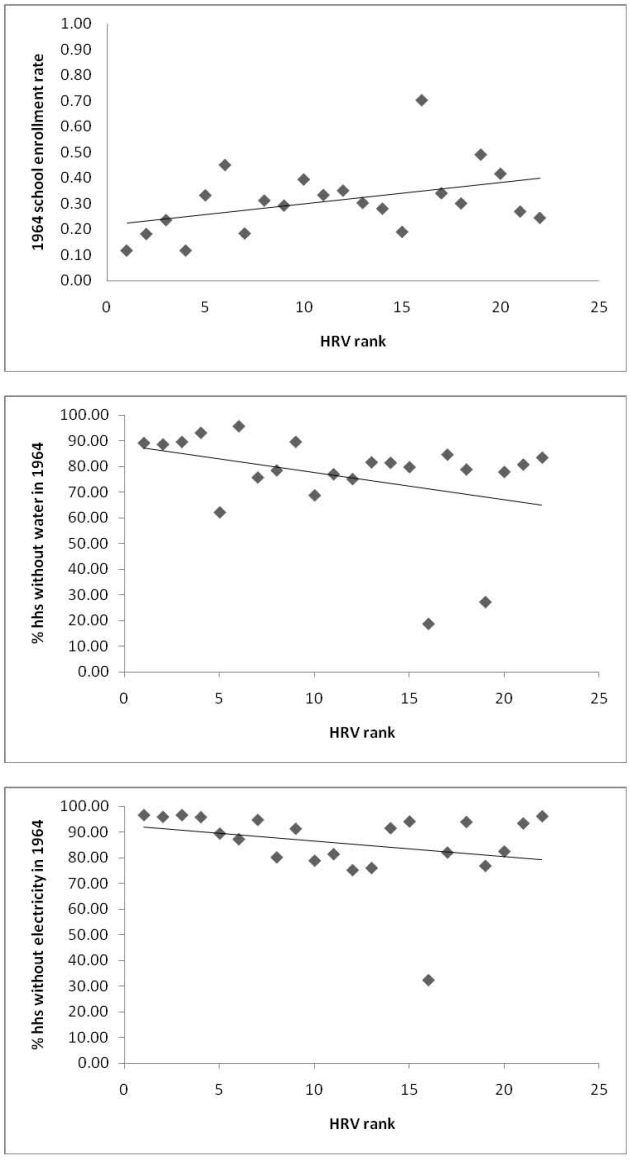


Figure 3.7: 1964 Enrollment Rates, Availability of Water and Electricity in 1964, and Rank of Departments (by Number of Victims)

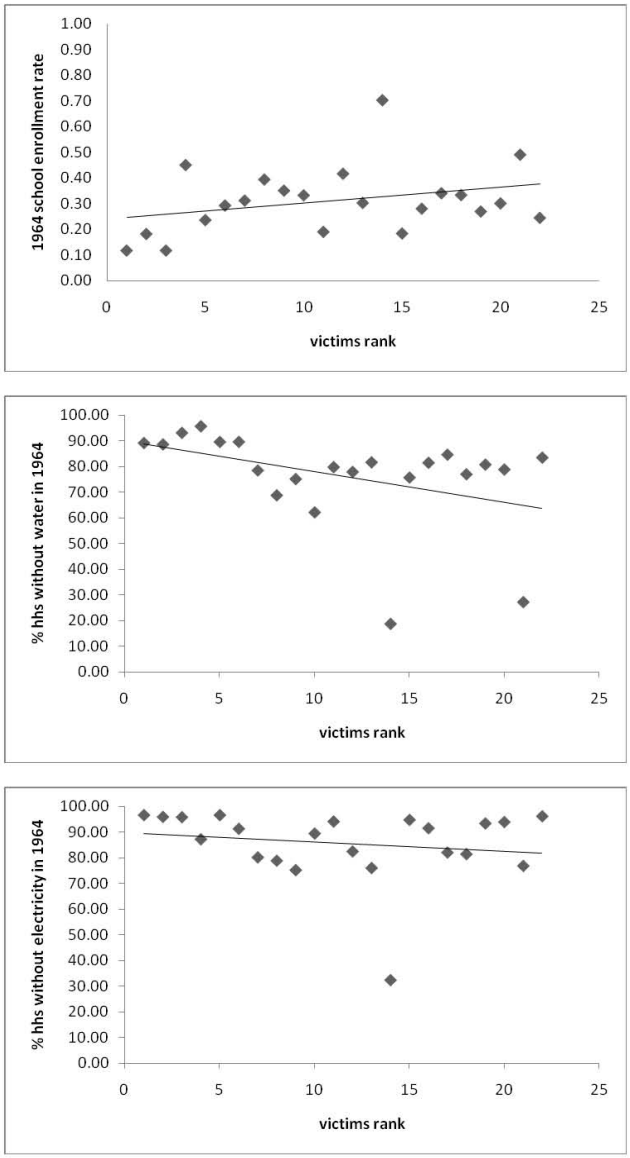


Table 3.1: Cohorts Unexposed and Exposed to the Civil War

Year of Birth	**Period During Which School Age (7-19 years)**	**Level of War Intensity**
1920-1941	Pre-War Period (before 1960)	None
1942-1960	Initial Period (1960-1978)	Low
1961-1977	Worst Period (1979-1984)	High
1978-1983	Latter Period (1985-1996)	Low

Table 3.2: Disparities in Educational Attainment: by Gender, Region, Sector, and Ethnicity

	All Individuals		Males		Females		(Males - Females)		(LWI - HWI)		
Panel A	**LWI**	**HWI**	**LWI**	**HWI**	**LWI**	**HWI**	**LWI**	**HWI**	**All**	**Males**	**Females**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Years of Schooling	4.64	2.37	5.03	2.92	4.28	1.87	0.75	1.06	2.27	2.11	2.42
Primary School	0.42	0.19	0.47	0.24	0.38	0.15	0.08	0.09	0.23	0.23	0.24
Secondary School	0.24	0.09	0.25	0.10	0.22	0.07	0.03	0.03	0.15	0.15	0.15
High School	0.15	0.05	0.16	0.06	0.14	0.04	0.02	0.01	0.10	0.10	0.10
Observations	3,436,013	1,103,656	1,632,588	525,675	1,803,425	577,981					

	All Individuals		Males		Females		(Males - Females)		(Urban - Rural)		
Panel B	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**All**	**Males**	**Females**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Years of Schooling	6.03	2.29	6.50	2.75	5.62	1.87	0.88	0.88	3.74	3.75	3.75
Primary School	0.57	0.18	0.62	0.22	0.53	0.14	0.10	0.08	0.39	0.40	0.39
Secondary School	0.36	0.05	0.39	0.07	0.33	0.04	0.05	0.02	0.30	0.32	0.29
High School	0.23	0.03	0.25	0.03	0.22	0.02	0.03	0.01	0.21	0.22	0.20
Observations	2,178,374	2,361,295	1,019,511	1,138,752	1,158,863	1,222,543					

	All Individuals		Males		Females		(Males - Females)		(Non-Mayan - Mayan)		
Panel C	**Non-Mayan**	**Mayan**	**Non-Mayan**	**Mayan**	**Non-Mayan**	**Mayan**	**Non-Mayan**	**Mayan**	**All**	**Males**	**Females**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Years of Schooling	5.39	2.24	5.66	2.90	5.14	1.65	0.52	1.25	3.15	2.76	3.49
Primary School	0.50	0.18	0.53	0.24	0.47	0.12	0.06	0.11	0.32	0.30	0.35
Secondary School	0.29	0.07	0.31	0.09	0.28	0.05	0.03	0.04	0.23	0.22	0.23
High School	0.19	0.04	0.19	0.05	0.18	0.03	0.01	0.02	0.15	0.15	0.16
Observations	2,659,416	1,880,253	1,263,981	894,282	1,395,435	985,971					

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Data for non-migrant individuals born between 1920 and 1983 are used to construct these figures.

Table 3.3: Difference-in-Differences Comparing Exposed with Unexposed Cohorts in High and Low War Intensity Departments: Years of Schooling for Males

	Urban Non-Mayan Males			**Urban Mayan Males**		
	HWI	**LWI**	**Difference (HWI-LWI)**	**HWI**	**LWI**	**Difference (HWI - LWI)**
Born 1978-1983 (Exposed 3)	8.4	8.47	-0.07	5.41	6.05	-0.64
	(0.031)	(0.008)	(0.032)	(0.027)	(0.017)	(0.032)
Born 1961-1977 (Exposed 2)	7.73	8.03	-0.30	4.40	4.88	-0.48
	(0.027)	(0.007)	(0.028)	(0.022)	(0.022)	(0.025)
Born 1941-1960 (Exposed 1)	6.28	6.60	-0.32	2.54	3.07	-0.53
	(0.037)	(0.01)	(0.039)	(0.024)	(0.014)	(0.028)
Born 1920-1941 (Unexposed)	3.94	4.60	-0.66	1.20	1.76	-0.56
	(0.050)	(0.016)	(0.053)	(0.026)	(0.026)	(0.031)
Difference (Exposed 3 - Unexposed)	4.46	3.87	0.59	4.21	4.29	-0.08
	(0.059)	(0.018)	(0.062)	(0.038)	(0.023)	(0.045)
Difference (Exposed 2 - Unexposed)	3.79	3.43	0.36	3.20	3.12	0.08
	(0.058)	(0.017)	(0.060)	(0.034)	(0.034)	(0.040)
Difference (Exposed 1 - Unexposed)	2.34	2.00	0.34	1.34	1.31	0.03
	(0.063)	(0.019)	(0.066)	(0.035)	(0.021)	(0.041)
	Rural Non-Mayan Males			**Rural Mayan Males**		
	HWI	**LWI**	**Difference (HWI-LWI)**	**HWI**	**LWI**	**Difference (HWI - LWI)**
Born 1978-1983 (Exposed 3)	4.33	4.73	-0.40	3.17	4.04	-0.87
	(0.024)	(0.010)	(0.026)	(0.010)	(0.013)	(0.017)
Born 1961-1977 (Exposed 2)	3.52	3.82	-0.30	2.18	2.94	-0.76
	(0.018)	(0.018)	(0.019)	(0.007)	(0.007)	(0.011)
Born 1941-1960 (Exposed 1)	1.96	2.31	-0.35	0.86	1.56	-0.70
	(0.019)	(0.007)	(0.021)	(0.006)	(0.008)	(0.01)
Born 1920-1941 (Unexposed)	1.05	1.31	-0.26	0.35	0.87	-0.52
	(0.021)	(0.021)	(0.023)	(0.006)	(0.006)	(0.011)
Difference (Exposed 3 - Unexposed)	3.28	3.42	-0.14	2.82	3.17	-0.35
	(0.032)	(0.013)	(0.035)	(0.012)	(0.016)	(0.020)
Difference (Exposed 2 - Unexposed)	2.47	2.51	-0.04	1.83	2.07	-0.24
	(0.028)	(0.028)	(0.030)	(0.00)	(0.00)	(0.016)
Difference (Exposed 1 - Unexposed)	0.91	1.00	-0.09	0.51	0.69	-0.18
	(0.029)	(0.011)	(0.031)	(0.009)	(0.012)	(0.015)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999).

Table 3.4: Difference-in-Differences Comparing Exposed with Unexposed Cohorts in High and Low War Intensity Departments: Years of Schooling for Females

	Urban Non-Mayan Females			**Urban Mayan Females**		
	HWI	**LWI**	**Difference (HWI-LWI)**	**HWI**	**LWI**	**Difference (HWI - LWI)**
Born 1978-1983 (Exposed 3)	7.97	8.27	-0.30	4.10	4.75	-0.65
	(0.031)	(0.009)	(0.032)	(0.027)	(0.016)	(0.031)
Born 1961-1977 (Exposed 2)	6.97	7.44	-0.47	2.65	3.14	-0.49
	(0.027)	(0.027)	(0.028)	(0.018)	(0.018)	(0.022)
Born 1941-1960 (Exposed 1)	4.85	5.59	-0.74	0.88	1.32	-0.44
	(0.035)	(0.01)	(0.036)	(0.015)	(0.01)	(0.018)
Born 1920-1941 (Unexposed)	2.84	3.78	-0.94	0.27	0.60	-0.33
	(0.042)	(0.042)	(0.045)	(0.012)	(0.012)	(0.016)
Difference (Exposed 3 - Unexposed)	5.13	4.49	0.64	3.83	4.15	-0.32
	(0.052)	(0.017)	(0.055)	(0.029)	(0.019)	(0.035)
Difference (Exposed 2 - Unexposed)	4.13	3.66	0.47	2.38	2.54	-0.16
	(0.050)	(0.050)	(0.053)	(0.022)	(0.022)	(0.027)
Difference (Exposed 1 - Unexposed)	2.01	1.81	0.20	0.61	0.72	-0.11
	(0.055)	(0.017)	(0.058)	(0.019)	(0.014)	(0.024)
	Rural Non-Mayan Females			**Rural Mayan Females**		
	HWI	**LWI**	**Difference (HWI-LWI)**	**HWI**	**LWI**	**Difference (HWI - LWI)**
Born 1978-1983 (Exposed 3)	3.57	4.27	-0.70	1.68	2.76	-1.08
	(0.022)	(0.010)	(0.024)	(0.008)	(0.011)	(0.014)
Born 1961-1977 (Exposed 2)	2.60	3.13	-0.53	0.80	1.55	-0.75
	(0.016)	(0.016)	(0.018)	(0.004)	(0.004)	(0.008)
Born 1941-1960 (Exposed 1)	1.09	1.54	-0.45	0.14	0.46	-0.32
	(0.016)	(0.006)	(0.017)	(0.002)	(0.004)	(0.005)
Born 1920-1941 (Unexposed)	0.58	0.83	-0.25	0.05	0.20	-0.14
	(0.017)	(0.017)	(0.019)	(0.002)	(0.002)	(0.005)
Difference (Exposed 3 - Unexposed)	2.99	3.44	-0.45	1.62	2.56	-0.93
	(0.028)	(0.013)	(0.031)	(0.008)	(0.012)	(0.015)
Difference (Exposed 2 - Unexposed)	2.02	2.30	-0.28	0.75	1.35	-0.60
	(0.024)	(0.024)	(0.026)	(0.005)	(0.005)	(0.009)
Difference (Exposed 1 - Unexposed)	0.51	0.71	-0.20	0.09	0.26	-0.17
	(0.024)	(0.01)	(0.026)	(0.003)	(0.006)	(0.007)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999).

Table 3.5: Civil War Exposure and Years of Schooling

Variable	Coeff.	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Using Human Rights Violations to Measure Civil War Intensity									
HRV * Born 1942-1960	β_1	1.2536***	0.2193	0.1734	-0.2701**	1.1517**	0.1766	-0.5201*	-0.1220*
		(0.3367)	(0.3156)	(0.4038)	(0.1112)	(0.4340)	(0.2049)	(0.2704)	(0.0656)
HRV * Born 1961-1977	β_2	0.8845	0.3263	0.9017	-0.7054**	1.3242*	0.2358	-0.4963	-0.5742**
		(0.6057)	(0.6179)	(0.5402)	(0.3395)	(0.6630)	(0.5801)	(0.6674)	(0.2799)
HRV * Born 1978-1983	β_3	0.2406	0.1345	0.8893	-1.0911**	0.6393	-0.0543	-0.4777	-1.1720**
		(0.6320)	(0.6576)	(0.6327)	(0.4893)	(0.5874)	(0.7627)	(0.9628)	(0.5035)
F-Statistics for:									
$Ho: \beta_1 = \beta_2$		0.55	0.08	11.32***	2.66	0.28	0.02	0.00	3.92*
$Ho: \beta_1 = \beta_3$		2.82	0.04	4.12**	3.81*	1.78	0.14	0.00	5.22**
$Ho: \beta_2 = \beta_3$		3.35*	0.72	0.00	3.02*	3.82*	1.29	0.00	5.69**
Observations		719,352	300,159	544,629	594,123	824,736	334,127	570,699	651,844
Adjusted R^2		0.1650	0.1620	0.1680	0.1730	0.1870	0.1830	0.1800	0.1680
Panel B: Using Victims to Measure Civil War Intensity									
Victims * Born 1942-1960	β_1	0.9215**	-0.0894	-0.0837	-0.3867***	0.8020**	-0.1851	-0.5911***	-0.0993**
		(0.3448)	(0.2669)	(0.2350)	(0.0936)	(0.3371)	(0.1977)	(0.1753)	(0.0474)
Victims * Born 1961-1977	β_2	0.3110	-0.0346	0.3899*	-0.5269**	0.5979*	-0.1253	-0.4053	-0.3403**
		(0.3818)	(0.3334)	(0.1965)	(0.1956)	(0.3379)	(0.3041)	(0.2866)	(0.1274)
Victims * Born 1978-1983	β_3	-0.0940	-0.1749	0.6276	-1.2115**	0.2868	-0.4168	-0.5475	-1.1512**
		(0.5757)	(0.5980)	(0.4438)	(0.4644)	(0.4767)	(0.6871)	(0.7258)	(0.4439)
F-Statistics for:									
$Ho: \beta_1 = \beta_2$		2.99*	0.08	10.99***	0.88	1.06	0.06	0.52	2.89*
$Ho: \beta_1 = \beta_3$		2.84	0.04	4.07**	3.83*	1.81	0.14	0.00	5.22**
$Ho: \beta_2 = \beta_3$		1.29	0.20	0.48	5.13**	0.99	0.50	0.09	6.14**
Observations		719,352	300,159	544,629	594,123	824,736	334,127	570,699	651,844
Adjusted R^2		0.1650	0.1620	0.1680	0.1730	0.1870	0.1830	0.1800	0.1680

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.6: Civil War Exposure and Years of Schooling: Control Experiment

Variable	Coeff.	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Using Human Rights Violations to Measure Civil War Intensity									
HRV * Born 1920-1941		0.7222	0.5385	-0.2905	0.1147	0.2423	0.0166	-0.1586	-0.0329
		(0.6252)	(0.4090)	(0.3183)	(0.1330)	(0.5212)	(0.1741)	(0.3311)	(0.0667)
Observations		78,125	35,692	71,779	69,483	91,596	37,005	61,843	65,070
Adjusted R^2		0.147	0.0441	0.0515	0.0448	0.124	0.0395	0.0388	0.0203
Panel B: Using Victims to Measure Civil War Intensity									
Victims * Born 1920-1941		0.4829	0.2735	-0.0836	0.0838	0.0731	0.1036	-0.1422	0.0024
		(0.4200)	(0.2231)	(0.2300)	(0.0778)	(0.3669)	(0.0772)	(0.2227)	(0.0453)
Observations		78,125	35,692	71,779	69,483	91,596	37,005	61,843	65,070
Adjusted R^2		0.1470	0.0441	0.0515	0.0448	0.1240	0.0395	0.0388	0.0203

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1904 and 1941 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.7: Completion of Primary School Grades: Using Human Rights Violations to Measure Civil War Intensity

Grade	Variable	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 1	HRV * Born 1942-1960	-0.1088***	0.0412	0.0121	-0.0320	-0.0372	0.0432	-0.1593***	-0.0304
		(0.0396)	(0.0348)	(0.0686)	(0.0280)	(0.0476)	(0.0358)	(0.0574)	(0.0193)
	HRV * Born 1961-1977	-0.2035***	0.1454***	0.1660**	-0.0204	-0.1701**	0.0389	-0.0332	-0.1071
		(0.0699)	(0.0506)	(0.0693)	(0.0684)	(0.0707)	(0.0693)	(0.0731)	(0.0727)
	HRV * Born 1978-1983	-0.2630***	0.1378***	0.1719***	0.0133	-0.2706***	0.0136	0.0153	-0.1848*
		(0.0744)	(0.0449)	(0.0571)	(0.0713)	(0.0802)	(0.0732)	(0.0658)	(0.0972)
Grade 2	HRV * Born 1942-1960	-0.1245***	0.0327	0.0002	-0.0449*	-0.0252	0.0353	-0.1689***	-0.0267
		(0.0423)	(0.0380)	(0.0658)	(0.0252)	(0.0446)	(0.0333)	(0.0562)	(0.0169)
	HRV * Born 1961-1977	-0.2442***	0.1214**	0.1338**	-0.0498	-0.1879***	0.0245	-0.0712	-0.1018
		(0.0759)	(0.0512)	(0.0649)	(0.0683)	(0.0676)	(0.0669)	(0.0759)	(0.0665)
	HRV * Born 1978-1983	-0.3029***	0.1145***	0.1277**	-0.0262	-0.2925***	-0.0051	-0.0202	-0.1885*
		(0.0811)	(0.0416)	(0.0567)	(0.0707)	(0.0793)	(0.0725)	(0.0726)	(0.0955)
Grade 3	HRV * Born 1942-1960	-0.0789*	0.0179	0.0187	-0.0382*	-0.0048	0.0247	-0.1250***	-0.0194*
		(0.0459)	(0.0391)	(0.0548)	(0.0191)	(0.0507)	(0.0309)	(0.0396)	(0.0104)
	HRV * Born 1961-1977	-0.2253***	0.0541	0.1311**	-0.0724	-0.1777**	0.0242	-0.1137	-0.0831
		(0.0807)	(0.0530)	(0.0516)	(0.0572)	(0.0661)	(0.0651)	(0.0830)	(0.0494)
	HRV * Born 1978-1983	-0.3210***	0.0376	0.1092**	-0.0923	-0.3027***	-0.0343	-0.0855	-0.1721**
		(0.0854)	(0.0466)	(0.0500)	(0.0655)	(0.0729)	(0.0736)	(0.0983)	(0.0846)
Grade 4	HRV * Born 1942-1960	0.0450	0.0231	-0.0083	-0.0290*	0.0995	0.0177	-0.0792**	-0.0112
		(0.0584)	(0.0433)	(0.0523)	(0.0171)	(0.0791)	(0.0258)	(0.0339)	(0.0070)
	HRV * Born 1961-1977	-0.1150	0.0161	0.0780	-0.0967*	-0.0371	0.0101	-0.1199	-0.0689**
		(0.0969)	(0.0726)	(0.0829)	(0.0486)	(0.0959)	(0.0666)	(0.1004)	(0.0331)
	HRV * Born 1978-1983	-0.2336**	-0.0356	0.0657	-0.1543**	-0.1555	-0.0452	-0.1150	-0.1530**
		(0.0926)	(0.0692)	(0.0805)	(0.0706)	(0.0925)	(0.0807)	(0.1336)	(0.0668)
Grade 5	HRV * Born 1942-1960	0.0819	0.0179	-0.0099	-0.0299*	0.1248	0.0126	-0.0399	-0.0101*
		(0.0579)	(0.0386)	(0.0464)	(0.0153)	(0.0766)	(0.0232)	(0.0263)	(0.0058)
	HRV * Born 1961-1977	-0.0713	-0.0024	0.0308	-0.1049**	0.0271	0.0061	-0.1334	-0.0620***
		(0.1004)	(0.0796)	(0.0852)	(0.0393)	(0.1007)	(0.0672)	(0.0953)	(0.0217)
	HRV * Born 1978-1983	-0.1954**	-0.0551	0.0093	-0.1840***	-0.0735	-0.0357	-0.1201	-0.1362**
		(0.0945)	(0.0797)	(0.0937)	(0.0636)	(0.0916)	(0.0884)	(0.1335)	(0.0510)
Grade 6	HRV * Born 1942-1960	0.1113*	0.0218	-0.0022	-0.0278*	0.1394*	0.0138	-0.0221	-0.0073
		(0.0632)	(0.0362)	(0.0421)	(0.0145)	(0.0763)	(0.0189)	(0.0246)	(0.0047)
	HRV * Born 1961-1977	-0.0374	-0.0042	0.0300	-0.1012***	0.0632	0.0092	-0.1253	-0.0498***
		(0.0978)	(0.0797)	(0.0881)	(0.0340)	(0.1059)	(0.0637)	(0.0889)	(0.0171)
	HRV * Born 1978-1983	-0.1548	-0.0444	0.0107	-0.1787***	-0.0118	-0.0238	-0.1213	-0.1151***
		(0.0976)	(0.0856)	(0.0959)	(0.0582)	(0.0996)	(0.0921)	(0.1348)	(0.0417)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.8: Completion of Secondary and High School Grades: Using Human Rights Violations to Measure Civil War Intensity

Grade	Variable	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 7	HRV * Born 1942-1960	0.2412***	0.0098	0.0285	-0.0151*	0.1720***	0.0035	0.0110	-0.0031
		(0.0464)	(0.0234)	(0.0249)	(0.0076)	(0.0388)	(0.0114)	(0.0129)	(0.0019)
	HRV * Born 1961-1977	0.3311***	-0.0091	0.0738	-0.0584***	0.3227***	0.0181	0.0228	-0.0243**
		(0.0599)	(0.0675)	(0.0494)	(0.0205)	(0.0799)	(0.0517)	(0.0434)	(0.0099)
	HRV * Born 1978-1983	0.2787***	-0.0207	0.0815	-0.1349***	0.3110***	0.0049	0.0057	-0.0596**
		(0.0528)	(0.0896)	(0.0731)	(0.0378)	(0.0762)	(0.0857)	(0.0825)	(0.0240)
Grade 8	HRV * Born 1942-1960	0.2444***	0.0117	0.0288	-0.0140*	0.1670***	0.0045	0.0155	-0.0035**
		(0.0463)	(0.0221)	(0.0230)	(0.0070)	(0.0377)	(0.0110)	(0.0120)	(0.0017)
	HRV * Born 1961-1977	0.3246***	-0.0024	0.0678	-0.0515***	0.3242***	0.0202	0.0194	-0.0222**
		(0.0602)	(0.0658)	(0.0459)	(0.0185)	(0.0774)	(0.0489)	(0.0390)	(0.0094)
	HRV * Born 1978-1983	0.2929***	-0.0127	0.0786	-0.1103***	0.3274***	0.0104	-0.0005	-0.0515**
		(0.0490)	(0.0840)	(0.0700)	(0.0327)	(0.0742)	(0.0831)	(0.0754)	(0.0215)
Grade 9	HRV * Born 1942-1960	0.2243***	0.0098	0.0337	-0.0111*	0.1498***	0.0062	0.0168	-0.0031*
		(0.0479)	(0.0204)	(0.0212)	(0.0065)	(0.0385)	(0.0099)	(0.0116)	(0.0018)
	HRV * Born 1961-1977	0.3053***	0.0060	0.0623	-0.0432**	0.3115***	0.0226	0.0221	-0.0186**
		(0.0516)	(0.0603)	(0.0403)	(0.0166)	(0.0700)	(0.0440)	(0.0342)	(0.0082)
	HRV * Born 1978-1983	0.2789***	-0.0045	0.0662	-0.0900***	0.3024***	0.0161	-0.0017	-0.0426**
		(0.0443)	(0.0759)	(0.0627)	(0.0286)	(0.0674)	(0.0737)	(0.0684)	(0.0182)
Grade 10	HRV * Born 1942-1960	0.2126***	0.0111	0.0272	-0.0093*	0.1306***	0.0055	0.0113	-0.0029
		(0.0512)	(0.0181)	(0.0172)	(0.0048)	(0.0320)	(0.0083)	(0.0106)	(0.0018)
	HRV * Born 1961-1977	0.2789***	-0.0024	0.0497	-0.0366***	0.2938***	0.0219	0.0177	-0.0137*
		(0.0449)	(0.0491)	(0.0316)	(0.0121)	(0.0622)	(0.0362)	(0.0280)	(0.0071)
	HRV * Born 1978-1983	0.3145***	0.0085	0.0708	-0.0546**	0.2990***	0.0198	-0.0045	-0.0273*
		(0.0398)	(0.0602)	(0.0486)	(0.0202)	(0.0644)	(0.0585)	(0.0535)	(0.0145)
Grade 11	HRV * Born 1942-1960	0.2010***	0.0090	0.0258*	-0.0102**	0.1262***	0.0040	0.0106	-0.0022
		(0.0483)	(0.0174)	(0.0150)	(0.0048)	(0.0329)	(0.0080)	(0.0107)	(0.0015)
	HRV * Born 1961-1977	0.2662***	-0.0015	0.0443	-0.0379***	0.2799***	0.0204	0.0105	-0.0124*
		(0.0432)	(0.0471)	(0.0302)	(0.0120)	(0.0608)	(0.0340)	(0.0271)	(0.0065)
	HRV * Born 1978-1983	0.2873***	0.0058	0.0578	-0.0448**	0.2727***	0.0139	-0.0123	-0.0239*
		(0.0403)	(0.0524)	(0.0416)	(0.0179)	(0.0582)	(0.0498)	(0.0480)	(0.0131)
Grade 12	HRV * Born 1942-1960	0.2040***	0.0132	0.0189	-0.0085*	0.1097***	0.0056	0.0091	-0.0020
		(0.0472)	(0.0172)	(0.0141)	(0.0045)	(0.0304)	(0.0072)	(0.0099)	(0.0016)
	HRV * Born 1961-1977	0.2749***	0.0053	0.0344	-0.0324***	0.2746***	0.0195	0.0079	-0.0103*
		(0.0443)	(0.0440)	(0.0284)	(0.0106)	(0.0532)	(0.0299)	(0.0239)	(0.0057)
	HRV * Born 1978-1983	0.2590***	0.0033	0.0401	-0.0344**	0.2335***	0.0111	-0.0176	-0.0175
		(0.0388)	(0.0428)	(0.0360)	(0.0153)	(0.0548)	(0.0384)	(0.0374)	(0.0107)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.9: Completion of Primary School Grades: Using Victims to Measure Civil War Intensity

Grade	Variable	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 1	Victims * Born 1942-1960	-0.0699**	-0.0058	-0.0563	-0.0752***	-0.0200	-0.0196	-0.1836***	-0.0206
		(0.0333)	(0.0288)	(0.0610)	(0.0273)	(0.0390)	(0.0315)	(0.0452)	(0.0164)
	Victims * Born 1961-1977	-0.1051***	0.0539**	0.0528*	-0.0457	-0.1011***	-0.0229	-0.0439	-0.0593
		(0.0348)	(0.0265)	(0.0303)	(0.0415)	(0.0357)	(0.0354)	(0.0374)	(0.0353)
	Victims * Born 1978-1983	-0.2235***	0.0910**	0.1026***	-0.0303	-0.2529***	-0.0493	-0.0090	-0.1753**
		(0.0572)	(0.0376)	(0.0353)	(0.0680)	(0.0620)	(0.0625)	(0.0500)	(0.0849)
Grade 2	Victims * Born 1942-1960	-0.0792***	-0.0128	-0.0566	-0.0851***	-0.0021	-0.0243	-0.1729***	-0.0219
		(0.0290)	(0.0313)	(0.0567)	(0.0240)	(0.0415)	(0.0336)	(0.0424)	(0.0140)
	Victims * Born 1961-1977	-0.1273***	0.0402	0.0411	-0.0616	-0.1082***	-0.0295	-0.0528	-0.0598*
		(0.0371)	(0.0255)	(0.0280)	(0.0410)	(0.0362)	(0.0349)	(0.0379)	(0.0318)
	Victims * Born 1978-1983	-0.2568***	0.0691**	0.0701*	-0.0668	-0.2690***	-0.0649	-0.0239	-0.1840**
		(0.0620)	(0.0308)	(0.0377)	(0.0670)	(0.0635)	(0.0619)	(0.0545)	(0.0832)
Grade 3	Victims * Born 1942-1960	-0.0351	-0.0188	-0.0276	-0.0676***	0.0118	-0.0371	-0.1214***	-0.0180*
		(0.0373)	(0.0332)	(0.0407)	(0.0179)	(0.0520)	(0.0370)	(0.0331)	(0.0096)
	Victims * Born 1961-1977	-0.1157**	0.0053	0.0487***	-0.0675*	-0.1069**	-0.0314	-0.0758**	-0.0507**
		(0.0464)	(0.0269)	(0.0172)	(0.0335)	(0.0401)	(0.0337)	(0.0367)	(0.0227)
	Victims * Born 1978-1983	-0.2764***	0.0008	0.0622	-0.1223*	-0.2857***	-0.0963	-0.0815	-0.1711**
		(0.0694)	(0.0380)	(0.0378)	(0.0617)	(0.0611)	(0.0615)	(0.0694)	(0.0743)
Grade 4	Victims * Born 1942-1960	0.0661	-0.0049	-0.0075	-0.0389***	0.0910	-0.0267	-0.0569*	-0.0095
		(0.0536)	(0.0420)	(0.0267)	(0.0133)	(0.0718)	(0.0318)	(0.0294)	(0.0068)
	Victims * Born 1961-1977	-0.0602	-0.0114	0.0545**	-0.0676**	-0.0328	-0.0271	-0.0640	-0.0416***
		(0.0581)	(0.0411)	(0.0219)	(0.0263)	(0.0561)	(0.0356)	(0.0390)	(0.0141)
	Victims * Born 1978-1983	-0.2122**	-0.0636	0.0663	-0.1646**	-0.1638**	-0.0898	-0.0923	-0.1515**
		(0.0783)	(0.0634)	(0.0465)	(0.0652)	(0.0793)	(0.0698)	(0.0911)	(0.0582)
Grade 5	Victims * Born 1942-1960	0.0894*	-0.0001	0.0075	-0.0338**	0.1105	-0.0242	-0.0152	-0.0077
		(0.0527)	(0.0361)	(0.0293)	(0.0127)	(0.0663)	(0.0268)	(0.0271)	(0.0052)
	Victims * Born 1961-1977	-0.0422	-0.0153	0.0369	-0.0680***	0.0060	-0.0238	-0.0713*	-0.0368***
		(0.0607)	(0.0441)	(0.0235)	(0.0205)	(0.0571)	(0.0360)	(0.0375)	(0.0090)
	Victims * Born 1978-1983	-0.1876**	-0.0733	0.0266	-0.1883***	-0.0878	-0.0727	-0.0948	-0.1339***
		(0.0819)	(0.0732)	(0.0548)	(0.0583)	(0.0773)	(0.0796)	(0.0938)	(0.0447)
Grade 6	Victims * Born 1942-1960	0.1136*	0.0103	0.0094	-0.0285**	0.1213*	-0.0127	-0.0055	-0.0050
		(0.0589)	(0.0340)	(0.0256)	(0.0111)	(0.0647)	(0.0224)	(0.0240)	(0.0046)
	Victims * Born 1961-1977	-0.0236	-0.0113	0.0311	-0.0634***	0.0273	-0.0142	-0.0726*	-0.0293***
		(0.0591)	(0.0447)	(0.0254)	(0.0173)	(0.0601)	(0.0344)	(0.0360)	(0.0074)
	Victims * Born 1978-1983	-0.1523*	-0.0559	0.0222	-0.1799***	-0.0300	-0.0504	-0.1042	-0.1130***
		(0.0857)	(0.0797)	(0.0562)	(0.0532)	(0.0852)	(0.0847)	(0.0993)	(0.0368)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.10: Completion of Secondary and High School Grades: Using Victims to Measure Civil War Intensity

Grade	Variable	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 7	Victims * Born 1942-1960	0.1436***	-0.0122	0.0035	-0.0124**	0.1061***	-0.0113	-0.0178**	-0.0041*
		(0.0462)	(0.0194)	(0.0156)	(0.0056)	(0.0287)	(0.0084)	(0.0081)	(0.0021)
	Victims * Born 1961-1977	0.1403***	-0.0225	0.0284	-0.0341***	0.1627***	0.0001	-0.0089	-0.0159***
		(0.0382)	(0.0380)	(0.0212)	(0.0114)	(0.0351)	(0.0277)	(0.0210)	(0.0058)
	Victims * Born 1978-1983	0.1800***	-0.0429	0.0561	-0.1324***	0.2444***	-0.0098	-0.0234	-0.0607**
		(0.0527)	(0.0861)	(0.0584)	(0.0366)	(0.0577)	(0.0804)	(0.0717)	(0.0234)
Grade 8	Victims * Born 1942-1960	0.1495***	-0.0094	0.0043	-0.0119**	0.0984***	-0.0085	-0.0088	-0.0039*
		(0.0455)	(0.0185)	(0.0148)	(0.0054)	(0.0270)	(0.0073)	(0.0076)	(0.0020)
	Victims * Born 1961-1977	0.1383***	-0.0177	0.0246	-0.0304***	0.1613***	0.0028	-0.0074	-0.0140**
		(0.0384)	(0.0369)	(0.0208)	(0.0102)	(0.0329)	(0.0257)	(0.0193)	(0.0055)
	Victims * Born 1978-1983	0.1971***	-0.0339	0.0537	-0.1084***	0.2580***	-0.0025	-0.0250	-0.0519**
		(0.0491)	(0.0806)	(0.0575)	(0.0317)	(0.0551)	(0.0776)	(0.0661)	(0.0209)
Grade 9	Victims * Born 1942-1960	0.1365***	-0.0115	0.0117	-0.0101*	0.0875***	-0.0051	-0.0059	-0.0035
		(0.0460)	(0.0173)	(0.0130)	(0.0051)	(0.0259)	(0.0060)	(0.0081)	(0.0021)
	Victims * Born 1961-1977	0.1313***	-0.0126	0.0231	-0.0260***	0.1582***	0.0055	-0.0042	-0.0118**
		(0.0331)	(0.0335)	(0.0173)	(0.0092)	(0.0305)	(0.0229)	(0.0173)	(0.0050)
	Victims * Born 1978-1983	0.1901***	-0.0259	0.0438	-0.0891***	0.2393***	0.0048	-0.0246	-0.0430**
		(0.0446)	(0.0725)	(0.0506)	(0.0276)	(0.0504)	(0.0685)	(0.0605)	(0.0180)
Grade 10	Victims * Born 1942-1960	0.1419***	-0.0081	0.0095	-0.0083*	0.0699***	-0.0034	-0.0055	-0.0027
		(0.0447)	(0.0149)	(0.0131)	(0.0041)	(0.0255)	(0.0059)	(0.0078)	(0.0018)
	Victims * Born 1961-1977	0.1284***	-0.0162	0.0183	-0.0219***	0.1476***	0.0069	-0.0021	-0.0084*
		(0.0253)	(0.0265)	(0.0160)	(0.0069)	(0.0299)	(0.0194)	(0.0136)	(0.0043)
	Victims * Born 1978-1983	0.2428***	-0.0108	0.0528	-0.0537***	0.2376***	0.0109	-0.0215	-0.0272*
		(0.0388)	(0.0567)	(0.0422)	(0.0197)	(0.0533)	(0.0548)	(0.0459)	(0.0144)
Grade 11	Victims * Born 1942-1960	0.1315***	-0.0097	0.0105	-0.0086**	0.0694**	-0.0072	-0.0020	-0.0013
		(0.0417)	(0.0152)	(0.0114)	(0.0042)	(0.0261)	(0.0056)	(0.0079)	(0.0013)
	Victims * Born 1961-1977	0.1209***	-0.0153	0.0167	-0.0223***	0.1415***	0.0043	-0.0035	-0.0070*
		(0.0258)	(0.0261)	(0.0154)	(0.0069)	(0.0300)	(0.0177)	(0.0129)	(0.0038)
	Victims * Born 1978-1983	0.2169***	-0.0130	0.0423	-0.0434**	0.2153***	0.0027	-0.0250	-0.0230*
		(0.0393)	(0.0494)	(0.0354)	(0.0174)	(0.0500)	(0.0455)	(0.0405)	(0.0127)
Grade 12	Victims * Born 1942-1960	0.1337***	-0.0063	0.0078	-0.0063	0.0581**	-0.0050	0.0044	-0.0010
		(0.0428)	(0.0149)	(0.0096)	(0.0039)	(0.0255)	(0.0058)	(0.0081)	(0.0010)
	Victims * Born 1961-1977	0.1261***	-0.0117	0.0137	-0.0184***	0.1424***	0.0041	0.0014	-0.0056*
		(0.0268)	(0.0244)	(0.0132)	(0.0061)	(0.0288)	(0.0164)	(0.0117)	(0.0030)
	Victims * Born 1978-1983	0.1878***	-0.0164	0.0289	-0.0323**	0.1813***	0.0005	-0.0223	-0.0165
		(0.0375)	(0.0396)	(0.0286)	(0.0147)	(0.0508)	(0.0354)	(0.0311)	(0.0100)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.11: Control Experiment Using Human Rights Violations to Measure Civil War Intensity

Grade	Males				Females			
	Urban		Rural		Urban		Rural	
	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 1	-0.2111**	0.0676	-0.0906	-0.0026	-0.0883	0.0209	-0.0589	-0.0011
	(0.0787)	(0.0803)	(0.0831)	(0.0324)	(0.0671)	(0.0280)	(0.0867)	(0.0165)
Grade 2	-0.1798*	0.0355	-0.0607	-0.0038	-0.0818	0.0163	-0.0402	-0.0022
	(0.0939)	(0.0785)	(0.0772)	(0.0271)	(0.0693)	(0.0240)	(0.0731)	(0.0151)
Grade 3	-0.0972	0.0654	-0.0384	0.0149	-0.0217	-0.0083	-0.0256	-0.0088
	(0.0738)	(0.0618)	(0.0603)	(0.0252)	(0.0733)	(0.0256)	(0.0546)	(0.0151)
Grade 4	0.1318*	0.1032**	-0.0165	0.0006	0.0719	0.0005	-0.0327	-0.0053
	(0.0696)	(0.0496)	(0.0482)	(0.0205)	(0.0772)	(0.0234)	(0.0385)	(0.0093)
Grade 5	0.1656**	0.0875*	-0.0133	0.0187	0.1086**	-0.0013	-0.0029	-0.0042
	(0.0658)	(0.0446)	(0.0348)	(0.0169)	(0.0477)	(0.0197)	(0.0383)	(0.0083)
Grade 6	0.1685***	0.0669	-0.0222	0.0165	0.0815*	0.0006	-0.0150	-0.0036
	(0.0620)	(0.0407)	(0.0321)	(0.0128)	(0.0473)	(0.0167)	(0.0370)	(0.0058)
Grade 7	0.1557**	0.0295	0.0005	0.0138*	0.0395	0.0110	0.0024	-0.0049**
	(0.0669)	(0.0277)	(0.0182)	(0.0074)	(0.0480)	(0.0128)	(0.0236)	(0.0023)
Grade 8	0.1332**	0.0267	-0.0044	0.0108*	0.0369	0.0002	-0.0015	-0.0017
	(0.0644)	(0.0246)	(0.0165)	(0.0060)	(0.0419)	(0.0139)	(0.0236)	(0.0022)
Grade 9	0.1285**	0.0125	-0.0192	0.0071	0.0391	-0.0069	-0.0038	-0.0015
	(0.0559)	(0.0223)	(0.0161)	(0.0056)	(0.0434)	(0.0109)	(0.0233)	(0.0020)
Grade 10	0.1229***	0.0134	-0.0085	0.0129**	0.0219	-0.0084	0.0026	0.0005
	(0.0440)	(0.0204)	(0.0141)	(0.0050)	(0.0389)	(0.0092)	(0.0113)	(0.0007)
Grade 11	0.1096**	0.0139	-0.0079	0.0134***	0.0134	-0.0039	0.0049	-0.0000
	(0.0445)	(0.0196)	(0.0140)	(0.0049)	(0.0383)	(0.0069)	(0.0121)	(0.0008)
Grade 12	0.0946**	0.0162	-0.0095	0.0125***	0.0213	-0.0040	0.0120	-0.0000
	(0.0431)	(0.0168)	(0.0145)	(0.0044)	(0.0462)	(0.0065)	(0.0095)	(0.0008)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.12: Control Experiment for Completion of School Grades Using Victims to Measure Civil War Intensity

Grade	Males				Females			
	Urban		Rural		Urban		Rural	
	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grade 1	-0.1419***	0.0213	-0.0253	0.0048	-0.0429	0.0262*	-0.0377	0.0078
	(0.0463)	(0.0448)	(0.0523)	(0.0194)	(0.0445)	(0.0142)	(0.0536)	(0.0115)
Grade 2	-0.1311**	0.0021	-0.0082	0.0045	-0.0359	0.0155	-0.0274	0.0057
	(0.0488)	(0.0440)	(0.0516)	(0.0162)	(0.0453)	(0.0120)	(0.0462)	(0.0111)
Grade 3	-0.0701*	0.0205	-0.0037	0.0149	-0.0000	0.0043	-0.0210	-0.0014
	(0.0400)	(0.0339)	(0.0413)	(0.0146)	(0.0455)	(0.0137)	(0.0365)	(0.0098)
Grade 4	0.0755	0.0549**	-0.0019	0.0003	0.0283	0.0146	-0.0290	-0.0021
	(0.0481)	(0.0256)	(0.0364)	(0.0124)	(0.0550)	(0.0118)	(0.0274)	(0.0061)
Grade 5	0.0967**	0.0489**	-0.0013	0.0096	0.0485	0.0083	-0.0088	-0.0015
	(0.0452)	(0.0240)	(0.0265)	(0.0095)	(0.0330)	(0.0104)	(0.0264)	(0.0052)
Grade 6	0.1027**	0.0375*	-0.0078	0.0082	0.0368	0.0110	-0.0168	-0.0007
	(0.0422)	(0.0213)	(0.0232)	(0.0077)	(0.0342)	(0.0075)	(0.0249)	(0.0039)
Grade 7	0.1112**	0.0216	-0.0008	0.0077*	0.0111	0.0129*	-0.0014	-0.0031**
	(0.0537)	(0.0144)	(0.0132)	(0.0044)	(0.0337)	(0.0067)	(0.0151)	(0.0014)
Grade 8	0.1020*	0.0175	-0.0039	0.0062*	0.0113	0.0065	-0.0044	-0.0011
	(0.0511)	(0.0136)	(0.0120)	(0.0037)	(0.0306)	(0.0071)	(0.0156)	(0.0013)
Grade 9	0.1010**	0.0119	-0.0132	0.0043	0.0143	0.0015	-0.0060	-0.0010
	(0.0448)	(0.0128)	(0.0122)	(0.0034)	(0.0288)	(0.0054)	(0.0155)	(0.0012)
Grade 10	0.0877**	0.0136	-0.0054	0.0076***	0.0005	-0.0012	0.0010	0.0002
	(0.0360)	(0.0119)	(0.0106)	(0.0028)	(0.0265)	(0.0050)	(0.0066)	(0.0003)
Grade 11	0.0780**	0.0128	-0.0055	0.0081***	-0.0026	0.0018	0.0022	-0.0002
	(0.0356)	(0.0114)	(0.0104)	(0.0027)	(0.0263)	(0.0034)	(0.0072)	(0.0004)
Grade 12	0.0712**	0.0111	-0.0065	0.0077***	0.0037	0.0022	0.0070	-0.0002
	(0.0337)	(0.0097)	(0.0106)	(0.0026)	(0.0299)	(0.0028)	(0.0052)	(0.0003)

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1904 and 1941 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

Table 3.13: Schooling of Migrant and Non-migrant Males

	Migrants from HWI Departments	Non-migrants in HWI Departments	Migrants from LWI Departments	Non-migrants in LWI Departments
		Urban non-Mayan Males		
Years of schooling	7.32	7.17	7.02	7.47
Primary school	0.71	0.68	0.69	0.72
Secondary school	0.46	0.44	0.42	0.47
High school	0.31	0.31	0.27	0.31
Observations	27,144	54,237	190,708	665,115
		Urban Mayan Males		
Years of schooling	4.41	3.91	5.31	4.36
Primary school	0.42	0.35	0.51	0.40
Secondary school	0.18	0.17	0.24	0.18
High school	0.10	0.10	0.14	0.10
Observations	16,832	81,519	28,624	218,640
		Rural non-Mayan Males		
Years of schooling	3.34	3.10	3.27	3.34
Primary school	0.30	0.25	0.29	0.29
Secondary school	0.11	0.07	0.10	0.09
High school	0.05	0.04	0.05	0.05
Observations	9,955	71,786	84,983	472,843
		Rural Mayan Males		
Years of schooling	1.94	1.91	2.85	2.60
Primary school	0.14	0.13	0.23	0.20
Secondary school	0.04	0.03	0.08	0.05
High school	0.02	0.01	0.03	0.03
Observations	25,314	318,133	14,907	275,990

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). The sample includes individuals born between 1920 and 1983. Migrants include individuals who have a different birth department and department of residence in December 1996. Non-migrants include individuals who have the same department of birth and department of residence in December 1996.

Table 3.14: Schooling of Migrant and Non-migrant Females

	Migrants from HWI Departments	Non-migrants in HWI Departments	Migrants from LWI Departments	Non-migrants in LWI Departments
		Urban non-Mayan Females		
Years of schooling	6.04	6.34	6.00	6.84
Primary school	0.58	0.59	0.57	0.65
Secondary school	0.35	0.38	0.33	0.43
High school	0.23	0.27	0.21	0.28
Observations	31,885	63,017	237,413	761,719
		Urban Mayan Females		
Years of schooling	2.65	2.37	3.55	2.83
Primary school	0.23	0.20	0.31	0.24
Secondary school	0.11	0.10	0.15	0.11
High school	0.06	0.06	0.08	0.06
Observations	15,989	91,597	28,571	242,530
		Rural non-Mayan Females		
Years of schooling	2.64	2.37	2.73	2.80
Primary school	0.21	0.17	0.22	0.23
Secondary school	0.08	0.06	0.08	0.08
High school	0.04	0.03	0.04	0.04
Observations	10,095	75,491	89,386	495,208
		Rural Mayan Females		
Years of schooling	0.83	0.81	1.62	1.44
Primary school	0.05	0.05	0.11	0.09
Secondary school	0.01	0.01	0.04	0.03
High school	0.01	0.00	0.02	0.01
Observations	23,592	347,876	14,753	303,968

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). The sample includes individuals born between 1920 and 1983. Migrants include individuals who have a different birth department and department of residence in December 1996. Non-migrants include individuals who have the same department of birth and department of residence in December 1996.

Table 3.15: Cohorts Used in Post-War Analysis

Grade	Cohorts Included in Sample	Cohorts of Grade-Specific Age		Age of Oldest Cohort	
		in 1978-1983	in 1997-2002	in 1997	in 2002
1	1978-1995	1978-1989	1990-1995	7	7
2	1978-1994	1978-1988	1989-1994	8	8
3	1978-1993	1978-1987	1988-1993	9	9
4	1978-1992	1978-1986	1987-1992	10	10
5	1978-1991	1978-1985	1986-1991	11	11
6	1978-1990	1978-1984	1985-1990	12	12

Table 3.16: Probability of Completing Primary School Grades for Post-War Cohorts

Dependent Variable	DID Variable	Males				Females			
		Urban		Rural		Urban		Rural	
		Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan	Non-Mayan	Mayan
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Using Human Rights Violations to Measure Civil War Intensity									
Grade 1	HRV * Born 1990-1995	0.0879***	-0.0094	0.0099	0.1110***	0.0795***	-0.0344	0.0591*	0.1361***
		(0.0222)	(0.0591)	(0.0210)	(0.0340)	(0.0191)	(0.0737)	(0.0340)	(0.0497)
Grade 2	HRV * Born 1989-1994	0.1038***	0.0023	0.0066	0.0960**	0.0907***	-0.0451	0.0702**	0.1220**
		(0.0248)	(0.0353)	(0.0241)	(0.0360)	(0.0195)	(0.0534)	(0.0323)	(0.0466)
Grade 3	HRV * Born 1988-1993	0.1140***	0.0111	0.0258	0.1229***	0.0652***	-0.0094	0.0781*	0.1052***
		(0.0308)	(0.0250)	(0.0306)	(0.0307)	(0.0230)	(0.0469)	(0.0419)	(0.0367)
Grade 4	HRV * Born 1987-1992	0.0938**	0.0289	0.0542	0.1328***	0.0276	0.0021	0.0950*	0.0737***
		(0.0357)	(0.0283)	(0.0531)	(0.0327)	(0.0352)	(0.0266)	(0.0553)	(0.0249)
Grade 5	HRV * Born 1986-1991	0.0461	0.0176	0.0657	0.1231***	0.0055	-0.0073	0.0685	0.0452**
		(0.0341)	(0.0325)	(0.0493)	(0.0308)	(0.0367)	(0.0250)	(0.0490)	(0.0173)
Grade 6	HRV * Born 1985-1990	0.0312	0.0144	0.0566	0.1108***	-0.0225	0.0112	0.0121	0.0398***
		(0.0292)	(0.0349)	(0.0451)	(0.0289)	(0.0383)	(0.0264)	(0.0467)	(0.0128)
Observations		438,123	190,566	373,220	402,864	459,363	203,007	377,937	426,130
Panel B: Using Victims to Measure Civil War Intensity									
Grade 1	Victims * Born 1990-1995	0.0456***	-0.0102	0.0103	0.0777***	0.0352**	-0.0274	0.0266*	0.0861**
		(0.0141)	(0.0364)	(0.0131)	(0.0225)	(0.0133)	(0.0455)	(0.0153)	(0.0326)
Grade 2	Victims * Born 1989-1994	0.0536***	-0.0049	0.0083	0.0669***	0.0443***	-0.0355	0.0357**	0.0769**
		(0.0176)	(0.0218)	(0.0147)	(0.0233)	(0.0131)	(0.0336)	(0.0171)	(0.0301)
Grade 3	Victims * Born 1988-1993	0.0603***	-0.0025	0.0119	0.0834***	0.0295*	-0.0116	0.0392*	0.0672***
		(0.0213)	(0.0144)	(0.0192)	(0.0195)	(0.0158)	(0.0289)	(0.0225)	(0.0240)
Grade 4	Victims * Born 1987-1992	0.0535**	0.0099	0.0129	0.0870***	-0.0001	0.0020	0.0382	0.0480***
		(0.0252)	(0.0160)	(0.0295)	(0.0204)	(0.0220)	(0.0161)	(0.0258)	(0.0168)
Grade 5	Victims * Born 1986-1991	0.0214	0.0008	0.0193	0.0768***	-0.0154	-0.0025	0.0235	0.0299**
		(0.0254)	(0.0203)	(0.0247)	(0.0191)	(0.0235)	(0.0145)	(0.0248)	(0.0121)
Grade 6	Victims * Born 1985-1990	0.0140	-0.0014	0.0213	0.0669***	-0.0303	0.0063	-0.0059	0.0247***
		(0.0215)	(0.0220)	(0.0218)	(0.0176)	(0.0242)	(0.0159)	(0.0258)	(0.0085)
Observations		438,123	190,566	373,220	402,864	459,363	203,007	377,937	426,130

Data Sources: 2002 National Population Census (Instituto Nacional de Estadistica (INE), Guatemala), Recovery of Historical Memory Project (1999), and Commission for Historical Clarification (1999). Robust standard errors in parentheses are clustered at the county level. * significant at 10%, ** significant at 5%, *** significant at 1%. The sample includes individuals born between 1920 and 1983 who have the same department of birth and department of residence in December 1996. All regressions include fixed effects for department and year of birth and interactions of year of birth indicators with the enrollment rate in 1964, the proportion of households without access to water in 1964, and the proportion of households without access to electricity in 1964.

4 Conclusions

This dissertation examined three topics related with migration and human capital formation in developing countries. The first chapter developed an endogenous growth model with intergenerational transfers and international migration to investigate how exposure to international migration affects physical-human capital formation and, hence, economic growth in the source countries. Migrants move to a higher wage country, where immigrants from their particular source country represent only a small fraction of the total population and hence are unable to affect real wages in the host country. The migrants do not carry physical capital from the source country to the host country. The human capital technology depends on private investment in, and real government expenditure on, education. Individuals behave altruistically toward their children and derive utility of living in the source country when older. The preference for joining the labor force in the source country captures the fact that workers are likely to have a preference for the country of their origin life-style because of cultural factors, family relationships, and so on.

Numerical simulations illustrated the relationships between exogenous parameters and the stationary migration rate and economic growth rate, in which were used standard values of the preference parameters and the parameters of the human capital and production functions. The main findings from comparative statics are as follows: (i) the migration rate is strictly increasing in the labor income tax rate, whereas the economic growth rate is non-monotonically associated with this parameter; (ii) the migration rate is strictly decreasing

in the preference for joining the labor market in the source country, while the economic growth rate is nonmonotonically correlated with that parameter; (*iii*) both the migration and the economic growth rates are strictly increasing in the host country real wages; (*iv*) both the migration rate and economic growth are strictly increasing in the parents' degree of human capital altruism; and (*v*) while the migration rate is strictly decreasing in the parents' degree of physical capital altruism, economic growth is strictly increasing in it.

Since in the analytical model of the first chapte individuals within, as well as across, generations are identical in their preferences and innate abilities, the results might change if one assumes heterogeneity in innate abilities. The findings would critically depend on whether it is assumed that high or low-skilled workers are more likely to emigrate. If high (low) skilled workers are more likely to emigrate, then the likelihood of adverse economic consequences may be magnified (contracted) due to the fact that the government expenditure on education per student would decrease (increase).

An extension of the theoretical analysis developed in the first chapter would be to assume a small open economy with perfect capital mobility. Since labor taxes are not a relatively important source of government revenue in labor-exporting countries, future work would also include a wider range of taxes such as the value added and tariffs. These taxes are much more important than labor taxes in non-OECD countries. The results in this paper might be affected if, instead of assuming a log utility function and a Cobb-Douglas human capital technology, one assumes a more general specification for those functions. Therefore, the results should be read taking into account the potential limitation of those specifications. Here, research is required.

The analytical model developed in the second chapter analyzes the determinants of individual migrant remittance behavior and extends the altruism-based frameworks proposed

by Lucas & Stark (1985) and Funkhouser (1995). This model predicts that migrants with higher labor income are more likely to remit and tend to remit more, households with lower income tend to receive more remittances, both the likelihood of remitting and remittance size are positively related to the degree of proximity between the migrants and the remaining household members in the source country and the relationship between migrant worker remittances and the length of stay in the host country might be non-monotonic over time. It also demonstrates that when forgone household labor income is taken into account the individual migrant remittance is a non-increasing function of household migration size. The main findings in the empirical part of this paper are generally supportive of the predictions of the model.

Future research related with remittances might be focused on the consequences of remittances for developing countries. Remittances may prove poverty-alleviating and reduce inequality, either directly through flows to the poor, if not the poorest, or indirectly through a stimulant effect on the local economy. Moreover, remittances may have long-term effects by overcoming liquidity constraints and allowing investment in the education and health care of receiving families. Similarly, remittances create a stable source of income which has a positive effect on exchange reserves and the balance of payments and might enhance financial development in small cities or towns of the source country. As foreign exchange inflow, remittances enter the economy in a different way than private capital inflows, foreign investment or financial aid, and, until now, there is no systematic study for a better understanding of those differences. In fact, macroeconomic effects remain poorly modeled and poorly understood. Particularly lacking are models that may facilitate the evaluation of both migration and remittance effects. However, many nations, like Ecuador, presume major benefits from remittance inflow and some actively promote additional flow, both

through efforts to lower transfer fees and through offers of alternatives for investment with government and international agency support.

In the third chapter, we investigate the impact of Guatemala's 36-year-long civil war (1960-1996) on educational outcomes of individuals. The empirical identification strategy uses a difference-in-differences approach by comparing the difference in the schooling of cohorts who were school age during the three periods of the war with those who had completed school age by 1960 in departments that experienced higher and lower war intensity. Besides including fixed effects for an individuals department of residence and year of birth, we also include interactions between year of birth indicators and the 1964 enrollment rate as well as interactions between year of birth indicators and the availability of water and electricity in a department in 1964. These interactions allow us to control for differences in pre-war levels of education and human development in higher and lower war intensity departments that may have influenced levels and trends in educational attainment in these departments even in the absence of the war.

We find a strong negative impact of the civil war on the education of rural Mayan males and females, which supports the conclusion that internal armed conflict reinforces poverty and social exclusion among the most vulnerable groups. Among rural Mayan males, those who were school age during the three periods of the civil war in departments where more human rights violations were committed completed 0.27, 0.71, and 1.09 years less of schooling respectively whereas rural Mayan females exposed to the three periods of the war completed 0.12, 0.47, and 1.17 years less of schooling respectively. Given an average of 4.66 and 3.83 years of schooling for males and females, these represent declines of 6, 15, and 23 percent for males and 3, 12, and 30 percent for females. Our results are robust to the inclusion of indicators for department of residence, year of birth, and controls for different

trends in education and human development in war affected and peaceful departments of Guatemala. Examining grade completion, we find that it was primarily due to a lower likelihood of completing primary school grades that rural Mayan males and females received less schooling as a result of the war. This result is not surprising since only 25 percent of the population in Guatemala receive more than a primary education. Finally, we find that rural Mayan males and females who were primary school age during post-war years in higher war intensity departments were more likely to complete each of grades 1 through 6 or higher, suggesting that at least primary school outcomes improved immediately after the war for the two groups most affected by it.

That the war had a negative impact on the education of males and females among the most disadvantaged group shows that it worsened the position of rural Mayans amongst the poorest groups by deteriorating their educational attainment. The war may have reinforced already existing gender, regional, sectoral, and ethnic differences in educational outcomes. Our post-war analysis indicates that at least primary school outcomes improved for rural Mayan males and females who were school age after the signing of the peace agreement in December 1996. While this result provides some evidence of post-war recovery, at least in terms of primary education, we cannot be certain that subsequent cohorts will experience similar improvements nor that existing educational disparities will be narrowed in the near future.

Bibliography

Abadie, A. & Gardeazabal, J. (2003), 'The economic costs of conflict: A case study of the Basque country', *American Economic Review* **93**(1), 112–132.

Agarwal, R. & Horowitz, A. (2002), 'Are international remittances altruism or insurance? evidence from guyana using multiple-migrant households', *World Development* **30**(11), 2033–2044.

Akresh, R., Bundervoet, T. & Verwimp, P. (2007), Civil war, crop failure, and child stunting in Rwanda. Households in Conflict Network Working Paper, 19.

Akresh, R., Bundervoet, T. & Verwimp, P. (2009), 'Health and civil war in Burundi', *Journal of Human Resources* **44**(2), 536–563.

Akresh, R. & de Walque, D. (2008), Armed conflict and schooling: Evidence from the 1994 Rwandan genocide. Households in Conflict Network Working Paper, 47.

Alderman, H., Hoddinott, J. & Kinsey, B. (2004), 'Long term consequences of early childhood malnutrition', *Oxford Economic Papers* **58**(3), 450–474.

Altonji, J., Hayashi, F. & Kotlikoff, L. (1997), 'Parental altruism and inter vivos transfers: theory and evidence', *Journal ofPolitical Economy* **105**, 1121–1166.

Amuedo-Dorantes, C. & Pozo, S. (2006), 'Remittances as insurance: evidence from mexican immigrants', *Journal of Population Economics* **19**, 227–254.

Andreoni, J. (1988), 'Privately provided public goods in a large economy: the limits of altruism', *Journal of Public Economics* **35**, 57–73.

Andreoni, J. (1990), 'Impure altruism and donations to public goods: a theory of warm-glow giving', *Economic Journal* **100**, 464–477.

Archdiocese of Guatemala (1999), *Guatemala never again!*, Orbis.

Barro, R. & Sala-i Martin, X. (1999), *Economic Growth*, MIT Press, Cambridge, MA.

Bergstrom, T., Blume, L. & Varian, H. (1986), 'On the private provision of public goods', *Journal of Public Economics* **29**, 25–49.

Bertrand, M., Duflo, E. & Mullainathan, S. (2004), 'How much should we trust difference-in-differences estimates?', *Quarterly Journal of Economics* **119**(1), 249–275.

Blankenau, W. & Simpson, N. (2004), 'Public education expenditure and growth', *Journal of Development Economics* **73**, 583–605.

Blankenau, W., Simpson, N. & Tomljanovich, M. (2007), 'Public education expenditures, taxation, and growth: linking data and theory', *AEA Papers and Proceedings* **2**, 393–397.

Blattman, C. & Annan, J. (2007), 'The consequences of child soldiering'. Households in Conflict Network Working Paper, 22.

Blattman, C. & Miguel, E. (2008), 'Civil war', *Journal of Economic Literature* **forthcoming**.

Borjas, G. (1987), 'Self-selection and the earnings of immigrants', *American Economic Review* **77**(4), 531–553.

Borjas, G. (1989), 'Economic theory and international migration', *International Migration Review* **23**(3), 457–485.

Brakman, S., Garretsen, H. & Schramm, M. (2004), 'The strategic bombing of cities in Germany in World War II and its impact on city growth', *Journal of Economic Geography* **4**(1), 1–18.

Cameron, A. & Trivedi, P. (2005), *Microeconometrics, Methods and Applications*, Cambrige University Press.

Cameron, A. & Trivedi, P. (2009), *Microeconometrics Using Stata*, Stata Press.

Card, D. & Kruger, A. (1992), 'Does school quality matter? returns to education and the characteristics of public schools in the united states', *Journal of Political Economy* **100**, 1–40.

Carrington, W., Detragiache, E. & Vishwanath, T. (1996), 'Migration with endogenous moving costs', *American Economic Review* **86**(4), 909–930.

Cerra, V. & Saxena, S. C. (2008), 'Growth dynamics: The myth of economic recovery', *American Economic Review* **98**(1), 439–457.

Chen, H. (2006), 'International migration and economic growth: a source country perspective', *Journal of Population Economics* **19**, 725748.

Chen, S., Loayza, N. V. & Reynal-Querol, M. (2008), 'The aftermath of civil war', *The World Bank Economic Review* **22**(1), 63–85.

Coleman, J. (1966), Equality of educational opportunity, Technical report, U.S. Government Printing Office, Washington, D.C.

Commission for Historical Clarification (1999), Guatemala: Memory of silence. http://shr.aaas.org/guatemala/ceh/report/english/toc.html.

Cox, A. & Ureta, A. (2003), 'International migration, remittances and schooling: evidence from el salvador', *Journal of Development Economics* **72**(2), 429–461.

Davis, D. R. & Weinstein, D. (2002), 'Bones, bombs, and breakpoints: The geography of economic activity', *American Economic Review* **92**(5), 1269–1289.

de Walque, D. (2006), 'The socio-demographic legacy of the Khmer Rouge period in Cambodia', *Population Studies* **60**(2), 223–231.

Desai, M., Kapur, D. & McHale, J. (2003), The fiscal impact of high skilled emigration: flows of Indians to the U.S. Weatherhead Center for International Affairs, Harvard University, Working Paper 0301.

Desai, M., Kapur, D., McHale, J. & Rogers, K. (2009), 'The fiscal impact of high-skilled emigration: flows of indians to the u.s.', *Journal of Development Economics* **81**(1), 32–44.

DiGeorgio-Lutz, J. & Hale, A. (2004), 'Internal displacement in Guatemala', *International Third World Studies Journal and Review, Volume XV, 2004* **15**.

Djajic, S. (1989), 'Skills and the pattern of migration: the role of qualitative and quantitative restrictions on international labor mobility', *International Economic Review* **30**(4), 795–809.

Docquier, F. & Marfouk, A. (2006), International migration by education attainment 1990-2000, *in* C. Özden & M. Schiff, eds, 'International migration, remittances, and the brain drain', The International Bank for Reconstruction and Development/The World Bank, Washington, DC.

Docquier, F. & Rapoport, H. (2006), The economics of migrants' remittances, *in* A. Gerard-Varet, C. Kolm & J. Mercier-Ythier, eds, 'Handbook on the Economics of Giving, Reciprocity, and Altruism', Vol. 2, Elevier-North Holland, pp. 1135–1198.

Duflo, E. (2001), 'Schooling and labor market consequences of school construction in indonesia: evidence from an unusual policy experiment', *American Economic Review* **91**(4), 795–813.

Dustmann, C. (1997), 'Return migration, uncertainty and precautionary savings', *Journal of Development Economics* **52**, 295–316.

Dustmann, C. (1999), 'Temporary migration, human capital, and language fluency of migrants', *Scandinavian Journal of Economics* **101**(2), 297–314.

Easterly, W. & Rebelo, S. (1993), 'Fiscal policy and economic growth', *Journal of Monetary Economics* **32**, 417–458.

Freeman, R. (1993), 'Immigration from poor to wealthy countries: experiences of the united states', *European Economic Review* **37**, 443–451.

Funkhouser, E. (1995), 'Remittances from international migration: a comparison of el salvador and nicaragua', *The Review of Economics and Statistics* **77**, 137–146.

Galor, O., Moav, O. & Volrath, D. (2009), 'Inequality in landownership, the emergence of human-capital promoting institutions, and the great divergence', *The Review of Economic Studies* **76**, 143–179.

Glomm, G. (1997), 'Parental choice of human capital investment', *Journal of Development Economics* **53**, 99–114.

Glomm, G. & Ravikumar, B. (1992), 'Public education versus private investment in human capital: endogenous growth and income inequality', *Journal of Political Economy* **100**, 818–834.

Glomm, G. & Ravikumar, B. (1998), 'Flat-rate taxes, government spending on education, and growth', *Review of Economic Dynamics* **1**, 306–325.

Hammar, T. & Tamas, K. (1997), Why do people go or stay?, *in* B. G. T. K. Hammar, T. & T. Faist, eds, 'International Migration, Immobility and Development: Multidisciplinary Perspectives', Oxford.

Hanson, G. & Woodruff, C. (2003), Emigration and educational attainment in mexico. University of California at San Diego.

IDBAmérica (online), Why emigrate? www.iadb.org/idbamerica/index.cfm.

Jokisch, B. (online), Ecuador: diversity in migration. www.migrationinformation.org.

Justino, P. & Verwimp, P. (2006), Poverty dynamics, violent conflict and convergence in Rwanda. Households in Conflict Network Working Paper, 16.

Kaganovich, M. & Zilcha, I. (1999), 'Education, social security, and growth', *Journal of Public Economics* **71**, 289–309.

Kotchen, M. & Moore, M. (2007), 'Private provision of environmental public goods: Household participation in green-electricity programs', *Journal of Environmental Economics and Management* **53**, 1–16.

Levine, R. & Renelt, D. (1992), 'A sensitivity analysis of cross-country growth regressions', *American Economic Review* **82**, 942–963.

Lucas, R. (2005), International migration regimes and economic development, Technical report, Report for the Expert Group on Development Issues (EGDI), Swedish Ministry of Foreign Affairs. Boston University.

Lucas, R. & Stark, O. (1985), 'Motivations to remit: evidence from botswana', *Journal of Political Economy* **93**(5), 901–918.

Miguel, E. & Roland, G. (2005), The long run impact of bombing Vietnam. Unpublished manuscript.

Mirrlees, J. (1982), 'Migration and optimal income taxes', *Journal of Public Economics* **18**, 319–341.

Mishra, P. (2007), 'Emigration and wages in source countries: evidence from mexico', *Journal of Development Economics* **82**, 180–199.

Miyagiwa, K. (1991), 'Scale economies in education and the brain drain problem', *International Economic Review* **32**(3), 743–759.

Moulton, B. (1986), 'Random group effects and the precision of regression estimates', *Journal of Econometrics* **32**(3), 385–397.

Moulton, B. (1990), 'An illustration of a pitfall in estimating the effects of aggregate variables on micro units', *The Review of Economics and Statistics* **72**(2), 334–338.

Organski, A. F. K. & Kugler, J. (1977), 'The costs of major wars: The Phoenix factor', *American Political Science Review* **71**(4), 1347–1366.

Organski, A. F. K. & Kugler, J. (1980), *The war ledger*, University of Chicago Press.

Osili, U. (2007), 'Remittances and savings from international migration: theory and evidence using a matched sample', *Journal of Development Economics* **82**(3), 446465.

Özden, C. & Schiff, M. (2006), *International migration, remittances, and the brain drain*, The International Bank for Reconstruction and Development / The World Bank, Washington, DC.

Perera, V. & Chauche, D. (1995), *Unfinished conquest: The Guatemalan tragedy*, University of California Press.

Przeworski, A., Alvarez, M. E., Cheibub, J. A. & Limongi, F. (2000), *Democracy and development: Political institutions and wellbeing in the world 1950-1990*, Cambridge University Press.

Quinn, J., Mason, T. & Gurses, M. (2007), 'Sustaining the peace: Determinants of civil war recurrence', *International Interactions* **30**(2), 167–193.

Secretaria Planificacion y Programacion (2006), Estrategia de Reducción de Pobreza. http://www.segeplan.gob.gt.

Shemyakina, O. (2006), The effect of armed conflict on accumulation of schooling: Results from Tajikistan. Households in Conflict Network Working Paper, 12.

Sjaastad, L. (1962), 'The costs and returns of human migration', *Journal of Political Economy* **70**(5), 80–93.

Stark, O., Helmenstein, C. & Prskawetz, A. (1998), 'Human capital depletion, human capital formation, and migration: a blessing or a "curse"?', *Economics Letters* **60**, 363–367.

Stewart, F., Huang, C. & Wang, M. (2001), Internal wars in developing countries: An

empirical overview of economic and social consequences, *in* F. Stewart & V. Fitzgerald, eds, 'War and underdevelopment', Oxford University Press.

Todaro, M. (1969), 'A model of labour migration and urban unemployment in ldcs', *American Economic Review* **59**, 138–148.

United Nations (2002), International migration report, Technical report, Department of Economic and Social Affairs, Population Division, United Nations.

Walmsley, T. & Winters, L. (2005), 'Relaxing the restrictions on the temporary movement of natural persons: a simulation analysis', *Journal of Economic Integration* **20**(4), 688–726.

Wilson, J. (2008), 'A voluntary brain-drain tax', *Journal of Public Economics* **92**, 2385–2391.

World Bank (online), World development indicators. www.worldbank.org.

Hilcías E. Morán

Banco de Guatemala
7a. Av. 22-01, Zona 1
Ciudad de Guatemala, Guatemala (01001)

Phone: (502) 2485 6000
Fax: (502) 2253 4035
Email: hems@banguat.gob.gt

CURRENT POSITION

Full-time Economic Researcher, Department of Economics Research, Banco de Guatemala, 2002-Present

PAST POSITIONS

Consultant, United Nations Development Program, Guatemala, Guatemala, March 2001February 2002

Research Analyst, Banco de Guatemala, Guatemala, 1999- Feb 2001

Economic Analyst, Banco de Guatemala, Guatemala, 1991-1999

EDUCATION

Ph.D., Economics, Indiana University, 2009

M.A., Economics and Public Policies, Universidad Torcuato Di Tella, Buenos Aires, 1998

B.S., Economics, Universidad de San Carlos de Guatemala, 1996.

DISSERTATION

Title: "Three essays on migration, remittances and human capital formation"

Chapter 1: "Migration, financing education and economic growth: an integrated Analysis"

Chapter 2: "Determinants of remittances: theory and evidence from households in ecuador"

Chapter 3: "Human capital consequences of civil war: evidence from guatemala" with Rubiana Chamabagwala, *Resubmitted*

Committee: Gerhard Glomm (Chair), Michael Alexeev, Rubiana Chamarbagwala and Ricardo López

FIELDS OF SPECIALIZATION

Monetary Economics, International Trade and Development, Growth Theory and Empirical Econometrics.

CONFERENCES

Latin American and Caribbean Economics Association (LACEA) Annual Meeting, Rio

2009. “Human capital consequences of civil war: evidence from guatemala”

Jordan River Conference, Indiana University, Bloomington, IN (2006). “Migration, remittances and economic growth”

VIII Meeting of the Central Bank Researchers Network of the Americas, Caracas, Venezuela (2003). “A Basic model of monetary policy for guatemala”

NON-REFEREED PUBLICATIONS

“A Basic model of monetary policy for guatemala”, 2004, *Monetaria*, Centro de Estudios Monetarios de Latinoamerica, 27 (4), Mexico

TEACHING EXPERIENCE

Financial Evaluation (Graduate), Universidad de San Carlos de Guatemala, 2003

Financial Programming (Undergraduate), Universidad Rafael Landivar, 2002-2003

Basic Macroeconomics (Undergraduate), Universidad Rafael Landivar, 1999-2002

SEMINARS

Building Models for Monetary Policy, Bank of England, London (November 2003)

Forecasting Macroeconomics and Finance, IMF Institute, Washington, D.C. (August 2003)

PERSONAL INFORMATION

Nationality: Guatemalan

Languages: Spanish, English